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CLARK

GAS
DYNATORK CARLOADER
MAINTENANCE MANUAL
NO. 52

FIRST EDITION

PRICE $3.00

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DCL-180LA

THIS BOOK COVERS MACHINE SERIAL NO. ~~DCL-393-CR.~~

Effective with Machine Serial No. DCL-393-L1 and Above

Mod

CLARK EQUIPMENT CO.

SERVICE DIVISION

JACKSON, MICHIGAN, U. S. A.

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PART I

Operation and Lubrication

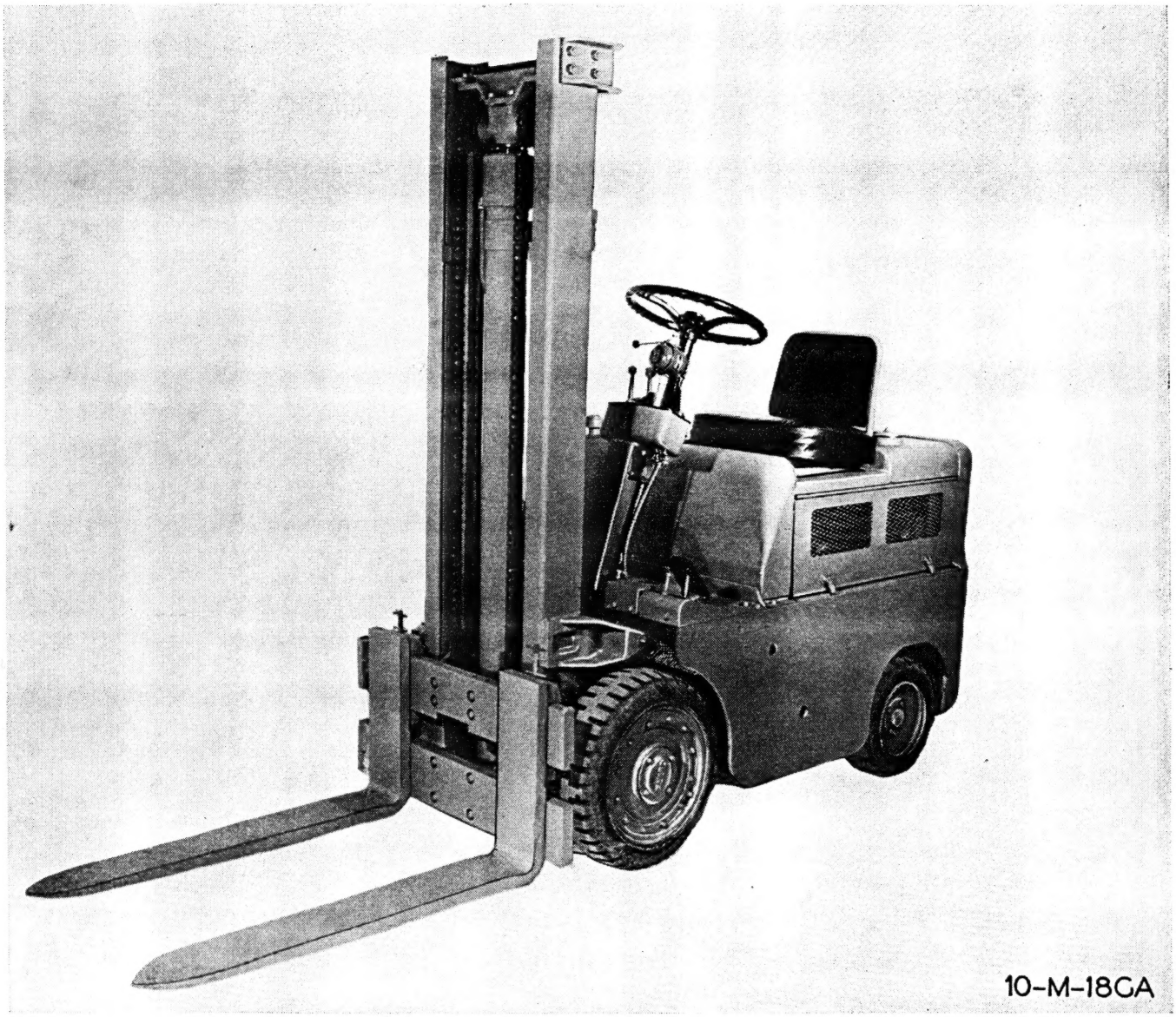

Fig. 1

PREPARATION OF MACHINE FOR OPERATION

1. This machine has a negative ground system. Check the negative (—) terminal of the battery and make certain the connecting cable is fastened to ground lead.

2. Check crankcase oil level on "dip stick" on right hand side of engine. Oil should register at "full" mark on "dip stick" gauge. Use the following recommended SAE viscosity oil, according to operating temperatures:

Below 0° F.—use SAE 10 oil
0° F to 32°—use SAE 20 oil
Above 32° F—use SAE 30 oil

3. Fill radiator with clean, preferably soft, water. Use anti-freeze when required. Capacity of cooling system is 14 quarts.

4. Fill fuel tank. Use good grade of regular gas. Capacity of fuel tank is approximately 5.5 gallons.

5. Check oil bath air cleaner cup. Oil should be at level mark (or slightly below when operating on ramps)

For operating temperatures

Below 0° F.—use SAE 10 oil
0° F to 32°—use SAE 20 oil
32° F and above—use SAE 30 oil

6. With operator in seat, turn on ignition key and start engine.

7. Immediately check ammeter to be sure hand registers on positive (+) side upon slight acceleration of engine.

8. Gasoline gauge should register according to amount of fuel in tank.

9. Oil pressure gauge should register 30-40 psi at top governor speed.

10. Check hydraulic system for proper oil level by raising uprights to maximum height. There should be sufficient oil to raise fork to maximum height without any jerking motion. If a jerky motion is encountered, add oil until motion smooths out.

11. Check circuit breaker under left hand hood louvre at back of sump tank assembly and make sure it is in the "on" position.

12. Driver's seat assembly is equipped with a safety control to the forward and reverse switch, which places the switch in neutral position when driver's weight is off the seat. Never try to force control lever into either direction when off the driver's seat.

13. Accelerator pedal is at the right of the brake pedal.

14. If machine fails to operate after engine is started, transmission in high or low range gears, forward or reverse switch in either position, and accelerated; then it will be necessary to have Dynatork unit checked for possible electrical failures.

15. The driver must turn off the ignition key when leaving machine for a short period of time. Place forks flat on the floor.

OPERATION OF CLARK DYNATORK

1. When sitting in the driver's seat, the forward and reverse control lever is located at the right hand side of steering column. Before starting the machine, this lever should be in neutral or the center position.

2. After the engine is started, select the high or low range gear with the shifting lever. Move the control lever forward to move the machine in that direction, or pull backward to move in reverse direction.

3. The control pedal that is in the usual position of clutch pedal should be used when the occasion calls for an "inching" movement.

4. The hydraulic controls are at the right of operator's seat. The inside control lever operates the tilt mechanism and the outer control lever operates the lift mechanism.

5. Machine is equipped with hydraulic service brakes and control pedal is located at right of steering column.

6. The parking brake on the Dynatork Carloader is controlled by a "Mico Brake Lock" to operate the parking brake.

1. Position switch located at right of driver's seat to the "on" position.

2. Press service brake foot pedal down to a braking position and then release to floorboard.

3. Turn brake switch to "off" position.

To release the parking brake, first apply service brakes in the normal manner and release pedal to floorboard with switch in the "off" position. This will automatically release the "Mico Brake Lock."

NOTE: After the parking brake has been applied, in order to release the brake, brake electrical control switch must be in the "off" position before applying service brake pedal. After the driver has applied the parking brake, the switch is to be turned to the "off" position. This will eliminate any draw on battery at this point.

AT THE BEGINNING OF EACH SHIFT

To place the machine into DAILY SERVICE the operator should:

1. Service the fuel tank.
2. Check the radiator.
3. Check the crankcase oil.
4. Service the air cleaner.
5. Inspect the tires.
6. Inspect the machine for general condition.
7. Upon starting the machine, check the instrument gauges, brakes, horn, hydraulic lift and tilt. Operate engine at idle speed for a few minutes until operating temperature is attained.

TO OPERATE THE CLARK DYNATORK

1. Drive at speeds recommended in your plant safety rules. Drive moderately and safely at all times.

2. The machine steers similarly to a highway vehicle, except steering axle is at rear of machine.

3. Place high-low range shift lever in desired position before shifting direction control lever.

4. Use foot control pedal for "inching" machine only.

CAPACITIES

Transmission and Drive axle—7 qts.
Fuel tank—5.5 gallons.
Cooling system—17 qts.
Crankcase—4 qts.
Air cleaner cup—1 pt.
Oil Filter Cartridge—1 qt.
Master brake cylinder—1 pt.

SAFETY AND OPERATING SUGGESTIONS

1. Only qualified operators should be permitted to operate a fork truck.

2. No one should operate a fork truck except the person to whom it is assigned.

3. Forks on moving machine must always be two inches from floor—or reasonably low—yet high enough to miss any floor obstructions.

4. The operator should face or look in the direction he is traveling.

5. When a load on a fork truck obstructs the vision of an operator, he should drive in reverse.

6. Operator should avoid bumping into objects with machine.

7. Operator should not drive with wet or greasy hands.

8. Extreme caution should be taken when operating on wet or slippery floors.

9. Operator should keep to right side of aisle whenever possible.

10. Operator should watch for other workman while machine is in motion.

11. Operator should slow down at cross-aisles, stop and sound horn before entering aisle.

12. Operator should move only safe loads and should not load his machine beyond its rated capacity.

13. Operator should not allow riders on his machine.

14. Operators should park machine only in parking area.

15. Forks on a parked truck should be flat on the floor.

16. A fork truck should not be left unattended with engine running.

17. Operator should attend to gasoline, crankcase oil, radiator, and air cleaner at the beginning of each shift.

18. Gasoline powered machine should be serviced only at designated points. Do not operate engine while servicing fuel tank.

19. If gasoline is spilled, it should be wiped up immediately and engine should not be started until all gasoline has evaporated.

20. Any apparent mechanical deficiency should be reported to foreman at once.

21. Forks must not be removed from machine except when changing to a special attachment.

22. If operator cannot start his machine in a few minutes, he should report to foreman.

GAS CARLOADER PREVENTIVE MAINTENANCE

SUGGESTIONS ON USING DAILY, WEEKLY, 300 HOUR AND SIX MONTHS P.M. FORMS.

One of the most important phases of a P.M. program is to keep the equipment clean. This saves time when routine checks and inspections are made, as well as when actual repair work is necessary. A better all around job of P.M. and repair will be done on the machine that is "spotless." Lubrication is likewise very important. When the equipment is clean, a quicker, easier and more efficient job will be done by the maintenance personnel. Washing complete machine is the No. 1 item on the weekly P.M. forms. There are several ways by which this may be done quickly and efficiently. Steam cleaning is very good, solvents of various kinds are also widely used, most of these are applied as a spray, then rinsed off with clean water under pressure. A good grade of strong soap and water will do a good job. It is essential that the machine be washed both inside and out. With a clean machine the time required for P.M. is cut to a minimum.

A good share of P.M. is merely a systematic periodic system of visual checks and inspections. These have been broken down into a Daily, Weekly (40-50 Operating Hours) 300 Hour and Six month check. The daily inspection includes the important things which must be done every day, such as: checking the crankcase oil level, checking and cleaning the air cleaner, both the oil cup and body every day if necessary. The fuel supply of course should be checked at the beginning of each shift, as well as the coolant level in the radiator. If machine is being used in cold temperatures, anti-freeze should be used in correct amount to prevent freezing. This will be determined by local conditions. Before starting the day's operations, the brakes, horn and all dash gauges must be given an operational and visual check. The brakes should "take hold" evenly and quickly when the brake pedal is depressed. If brakes are correctly adjusted and in good condition it should not be necessary to depress pedal more than two inches before brakes start to "take hold."

The weekly P.M. check is continuation of the daily with the addition, mainly, of a complete lubrication job. The lubrication chart which is received with each machine should be closely followed in regard to this work. In this phase of the P.M. program, proper equipment is essential for a first class job both in using the correct lubricant and having proper equipment to apply it. There are several types of pressure operated grease guns which are very good and any one of them will do a good job. Greases and lubricants which will be needed are as follows:

1. semi-fluid chassis grease
2. No. 90 transmission lube
3. No. 250 steering gear grease
4. wheel bearing fibre grease
5. graphite paste
6. SAE wt. oil suitable for engine
7. No. 10W for hydraulic system

Other important parts of the weekly inspection besides lubrication, include a check of the fuel system for leaks, clogged lines and screens, and also good operation of carburetor. The cooling system is checked for leaks, clogged overflow pipe in radiator, and radiator is checked for cleanliness both inside and out.

Steering gear assembly is checked for security of mounting and operation.

The hydraulic system is inspected for leaks, and probably the easiest way to make a leak show up is to operate tilt both forward and backward to its limits and allow the pressure to build up for two or three seconds and over-ride the relief valve, the same thing can be done with the lifting system.

The engine crankcase is vented by means of a vent pipe located on the side of the engine valve chamber cover. It is very important that this vent

pipe be kept free of any obstructions. If this becomes clogged, it will allow a "back pressure" to build up in the crankcase, which will force the crankcase oil up around the piston rings and cylinder walls, and into the combustion chamber. This causes a smoking engine and in time will cause sticky valves, frozen rings, and a clogged manifold, as well as fouled spark plugs.

On the three hundred-hour check which is in addition to the weekly, a motor tune up is recommended. The ignition system, fuel system, including carburetor and governor, and the electrical system is given a complete check for proper clearances and adjustments. This of course will keep the engine running at its highest point of efficiency. It should also uncover any small troubles which later may develop into a break-down or make a complete overhaul necessary. In the 300-hour check, the upright and lift part of the hydraulic system, as well as the tilt system, is given a thorough check. They are both checked for "drift." A capacity load should be used in this check. It should be elevated a few feet and tilted to vertical position, and the valve control handle returned to neutral. It can then be noted if the upright assembly drifts forward, or if the lift cylinder tends to slowly settle. If the load settles it means that the lift cylinder piston leathers will soon have to be replaced. If the upright assembly drifts forward, the same is true of the tile cylinder leathers.

The steering system is given a complete check on this inspection. Probably the most important point on this check is to be sure that the stops on the wheel spindles contact the adjustable stops on the steer axle when the wheels are turned to the extent of its turning radius, before the roller assembly in the steering gear, gear box has bottomed. If the roller assembly is allowed to bottom it will quickly wear out the roller thrust bearing in the gear box and cause a breakdown.

Another important check at this time is made to be sure the spring leaf "U" bolts are tight. Loose "U" bolts are the most common cause of spring leaf failure. If spring assemblies are replaced they should be replaced in pairs, as the increased arch in a new spring being used in conjunction with an old spring will tend to carry most of the weight and cause hard steering and abnormal tire wear. This of course does not hold true on machines equipped with a pivot axle.

The drive axle, motor supports and muffler are checked for security of mounting and tightness of all bolts, nuts, and cap screws.

The six month check involves the removal of drive and steer wheels for inspection and cleaning and repacking with proper lubricant all gears, bearings, and bearings races. The condition of the brake lining and brake drums are also noted at this time.

The lift chains should be removed and cleaned with kerosene, oiled, reinstalled and adjusted. The hydraulic system should be checked for pressure. A pressure gauge can be connected to either of the tilt lines or the lift line, whichever is most convenient. The engine should be accelerated at about half speed and the valve contact lever moved to a position which will show a reading on the gauge. This should show a reading of 1250 P.S.I. This pressure can be changed by adjusting the pressure relief valve on the hydraulic control valve. Clockwise adjustment increases the pressure, counter-clockwise decreases it.

This system of checks and inspections is set up to increase the life of your Clark fork truck, to reduce down-time to a minimum and to keep operating costs at the very lowest. P.M. is a good insurance on a good investment.

AIR CLEANER OPERATION AND CARE

The air cleaner is put on the engine to prolong its life and performance by preventing dirt and grit from getting into the engine, causing excessive

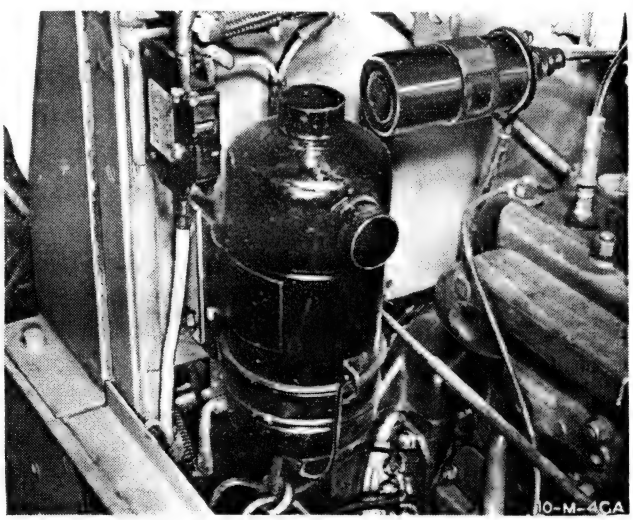

Fig. 2

wear on all operating parts. However, the operator is of necessity charged with the responsibility of giving the air cleaner equipment regular and constant attention in accordance with the instructions.

Service air cleaner daily—more frequently under severe dust conditions. Remove oil cup, empty oil, scrape out dirt. Fill to oil level head with engine oil. Replace oil cup securely. Never remove oil cup while engine is running.

The oil cup should be kept filled as near as possible, to the level indicated by the bead, with fresh oil. We recommend the following grades be used:

SAE 10 Oil—In freezing weather. 20 Oil—in warm weather. 30 Oil—in hot weather.

The best performance of the air cleaner is obtained by keeping the oil level up to the bead on the cup. Raising the oil level above this point does not increase the efficiency and this practice should be avoided.

It is absolutely necessary to change oil and thoroughly clean the cup whenever (or before) the level of dirt accumulated in the bottom of the cup reaches ⅓", or the oil appears too thick or heavy to spray or circulate properly. The depth of dirt at the bottom can be measured with a stick, screw driver, or whatever is convenient. Daily inspection is necessary to enable the operator to see when any of these conditions have been reached.

Ordinarily, if the correct oil level is maintained with the proper grade of oil, the wire screen filtering element will need weekly attention. However the bottom of the screen element should be inspected daily when the cup is removed and any accumulation of heavy lint, or other material removed.

All connections between the air cleaner and carburetor should be inspected at frequent intervals and must be kept tight.

OIL FILTER

When the crankcase oil becomes a smoky or black color shortly after an oil change in the motor, a new filter cartridge should be installed. To do this, remove top of oil filter by unscrewing handle. Lift old cartridge out by means of the wire attached to the cartridge. Before installing the new one, dip it in fresh, clean oil so that it will slip in more easily. A new filter may be required in from 40 to 50 hours of operation, depending on the quality of oil used and operating conditions.

GASOLINE POWERED FORK TRUCK DAILY CHECK SHEET

SUGGESTIONS:

At the beginning of each day (or shift):

A. Check "dip stick" in crankcase—oil should show level at (or slightly below) mark. Oil should look clean. Use SAE No. 10 for temperatures below 0° F. SAE No. 20 for temperatures 32° F., and SAE No. 30 for temperatures above 32° F.

B. Change oil in air cleaner cup—clean cup and refill to level with SAE No. 10 oil for temperatures below 0° F., and SAE No. 20 at temperatures of 0° F to 32° F. For temperatures above 32° F., use SAE No. 30 oil.

C. Brakes — the service (foot) pedal should show good brakes. Brakes should take hold upon being depressed 1" to 2". If brakes do not hold, then they should be adjusted and checked. The parking brake should hold the machine properly.

D. The horn is a safety unit. It should sound. If it does not, it should be repaired or replaced.

E. Check the radiator coolant level and if antifreeze is used, be sure the mixture will be "safe" at operating temperatures.

F. The dash gauges should register. The gasoline gauge should register according to the fullness of the tanks. The ammeter will register on positive side upon acceleration of motor. The oil pressure gauge should register 30-40 psi at top governor speed.

PREVENTIVE MAINTENANCE

CLARK DYNATORK

EIGHT HOUR (DAILY) CHECK

DATE_____ MACHINE NO._____ OPERATOR_____

	MON.	TUES.	WED.	THURS.	FRI.	SAT.	SUN.
Crankcase—Oil Level O.K.							
Pints added							
Needs changing							
Gasoline—Gallons							
Air Cleaner—Cup Cleaned							
Screen O.K.							
Brakes—Service Brakes O.K.							
Hand Brake O.K.							
Horn—Operates O.K.							
Radiator—Water Level O.K.							
Anti-freeze O.K.							
Dash Gauges—Gasoline							
Ammeter							
Temperature							
Oil Pressure							
Hydraulic—Lift O.K.							
Tilt O.K.							
Tires							

PREVENTIVE MAINTENANCE
CLARK DYNATORK CARLOADER
40-50 HOURS (WEEKLY) CHECK

☐ 1. Wash or clean machine completely.

☐ 2. Complete Lubrication

A. High pressure fittings

- ☐ Spring shackles—6 fittings
- ☐ Steer axle tie rods—4 fittings
- ☐ Steer axle spindle pins—4 fittings
- ☐ Steer axle center pin—1 fitting
- ☐ Steer axle pivoted axle—2 fittings
- ☐ Steer axle drag link—2 fittings
- ☐ Brake pedal shaft—1 fitting
- ☐ Tilt cylinder pivot pins—4 fittings
- ☐ Lift chain sprockets—2 fittings
- ☐ Lift carriage—4 fittings
- ☐ Lower upright pivot caps—2 fittings
- ☐ Water pump—1 fitting
  Note: Use only water pump lubricant

B. Grease Cups

- ☐ Distributor—keep filled with grease (No. 2 cup)

C. Oil Cups (SAE No. 10 oil)

- ☐ Generator—2 cups—1-2 drops
- ☐ Starter—1 cup—1-2 drops

D. Linkage, toggles, etc. (SAE No. 10 oil)

- ☐ Distributor—Cam pad—1 drop
- ☐ Wipe drop of oil on lobes
- ☐ Accelerator connections
- ☐ Control and brake connections
- ☐ Lift chains—paint on oil with 1" paintbrush and wipe off excess.

E. Crankcase

- ☐ Change engine oil
- ☐ Change oil filter cartridge

F. Air Cleaner

- ☐ Remove air cleaner body—wash in kerosene—blow out—replace
- ☐ Clean cup—refill to oil level
  Use SAE No. 10—0° F. and below
  SAE No. 20—0° F to 32° F.
  SAE No. 30—32° F and above

G. Innerslides

- ☐ Wipe off innerslides, apply thin coating graphite paste

H. Check Battery

- ☐ Clean terminals—check electrolyte cells
  No. 1 ☐ 2 ☐ 3 ☐

I. Hydraulic Sump Tank

- ☐ Oil level
- ☐ Clean filler cap

☐ 3. Clean fuel screens at fuel pump and carburetor.

☐ 4. Radiator

- ☐ Check cap and gasket
- ☐ Blow out core if plugged with lint or dirt
- ☐ Check overflow pipe to prevent clogging
- ☐ Check for water leaks
- ☐ Adjust fan belt

☐ 5. Steering Gear—Check for security at mounting

☐ 6. Brake—Check

- ☐ Free Play (¼" at pedal)
- ☐ Brakes hold
- ☐ Pedal return spring

☐ 7. Hydraulic system—Check for leaks at:

- ☐ Pump
- ☐ Valve
- ☐ Tilt Cylinders
- ☐ Sump tank

☐ 8. Protectoseal gasoline cap

- ☐ Screen clean
- ☐ Cap secure

☐ 9. Blow out forward and reverse rotor with dry air. This is accessible through wire screen at top of housing.

300 HOURS (MONTHLY) CHECK PLUS WEEKLY CHECK

- ☐ 10. Manifold
  - ☐ Heat Control
  - ☐ Gasket
  - ☐ Nuts
  - ☐ Check for leaks
- ☐ 11. Fuel Pump
  - ☐ Remove and clean
  - ☐ Check pressure and vacuum (if needed)
- ☐ 12. Oil Pressure
- ☐ 13. Wiring—check all wires and tighten
- ☐ 14. Battery specific gravity
  - ☐ Add water ¼" over plates
- ☐ 15. Tappets
  - ☐ Adjust (.014")
  - ☐ Clean valve chamber and cover (making certain breather pipe is clean)
- ☐ 16. Tilt Cylinders
  - ☐ Tighten glands
  - ☐ Equalize forward and backward tilt
  - ☐ Tighten boots
  - ☐ Check head studs
  - ☐ Check drift under capacity load—½" Five minutes allowable.
- ☐ 17. Uprights
  - ☐ Inspect Carriage
  - ☐ Inspect thrust rollers
  - ☐ Equalize chains
  - ☐ Inspect slides
  - ☐ Check drift with capacity load (¼" 5 min.)
  - ☐ Tighten all fasteners
- ☐ 18. Steering Axle
  - ☐ Check and adjust tie rods
  - ☐ Check tie rod ends
  - ☐ Check drag links
  - ☐ Spindle and arm assembly
  - ☐ Set Timing radius
- ☐ 19. Springs
  - ☐ Check and tighten "U" bolts
  - ☐ Check spring shackles
  - ☐ Check spring clips
- ☐ 20. Drive Axle
  - ☐ Check lubricant
  - ☐ Check mounting bolts
  - ☐ Check for leaks
  - ☐ Change lubricant if needed
- ☐ 21. Muffler
  - ☐ Remove and clean (if condensing muffler)
- ☐ 22. Steering
  - ☐ Adjust if needed
- ☐ 23. Check brushes for wear. Clean with carbon tetrachloride and wipe with clean cloth. Replace if necessary.

1000 HOURS (6-MONTH) CHECK PLUS MONTHLY CHECK PLUS WEEKLY CHECK

- ☐ 24. Check all items on previous check sheets (8 hour; 40-50 hour; 300 operating hours)
- ☐ 25. Steering Wheels
  - ☐ Remove—Clean—Check seal
  - ☐ Check and repack bearings. Use wheel bearing grease.
- ☐ 26. Drive Wheels
  - ☐ Remove—Clean
  - ☐ Clean—Repack bearings
  - ☐ Brake drum condition
  - ☐ Clean, repack spur gear
  - ☐ Clean, repack ring gear. Use wheel gearing grease
  - ☐ Clean and repack pinion drive shaft bearings (wheel bearing grease)
- ☐ 27. Brakes—Condition of linings
- ☐ 28. Lift Chains
  - ☐ Remove—Clean—Lubricate
  - ☐ Install—Adjust
- ☐ 29. Brake Pedal
  - ☐ Support shaft
  - ☐ Bushings
- ☐ 30. Hydraulic system
  - ☐ Pump pressure
  - ☐ Valve pressure—
    Standard Upright 1200 psi
  - ☐ Remove, clean sump well screen (Replace gaskets)
- ☐ 31. Forks
  - ☐ Even mounting (¼" difference at end allowable)
  - ☐ Mounting bracket
- ☐ 32. Drive Axle—Transmission
  - ☐ Change Lubricant
- ☐ 33. Tighten all frame fasteners

LUBRICATION INSTRUCTIONS

1. **DISTRIBUTOR GREASE CUP:** Give one complete turn every 40 operating hours and keep filled with No. 2 cup grease. Remove distributor cap and oil under rotor with a drop of light oil every 40 operating hours. Wipe cam lightly with thin film of oil or grease.

2. **WATER PUMP:** Equipped with a low pressure fitting—use hand grease gun 2 strokes. Caution: Use only water pump grease. Lubricate every 40 operating hours.

3-4. **GENERATOR BEARINGS:** Both front and rear should be lubricated with one or two drops of SAE-10 oil every 40 operating hours.

5. **CRANKCASE FILLER PIPE:** Capacity 4 quarts and one pint in filter. Oil in crankcase is to be changed every 40 operating hours. In temperatures above 32° F., during normal service, SAE-30 oil should be used. In winter months, during normal service, SAE-20 oil should be used except when temperatures are below 0° F., when SAE-10W should be used. (Oil filter cartridge should be changed every time oil is changed.)

6. **FRONT STARTER BEARING:** Should be oiled with one or two drops of SAE-10 oil every 40 operating hours.

7. **BAYONET OIL GAUGE (OR DIP STICK):** Check daily for oil level and cleanliness. Oil should indicate to the full mark at all times when machine is standing level.

8. **CRANKCASE DRAIN PLUG:** On lower right hand side of motor. Crankcase should be drained every 40 operating hours and then filled with 4½ quarts of good grade crankcase oil in accordance with No. 5. Caution: Always change the oil filter cartridge every time the oil is changed to keep the new oil clean and to keep the internal lubricated parts of the motor free from any unnecessary dirt or grit.

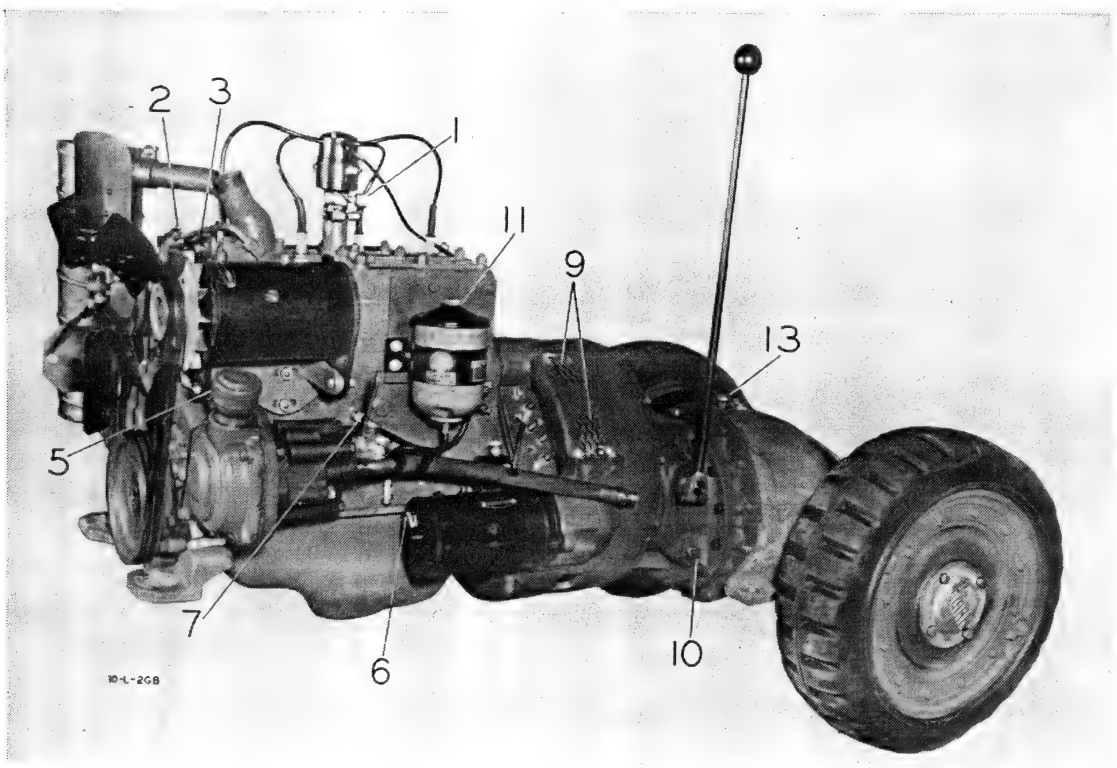

Fig. 3

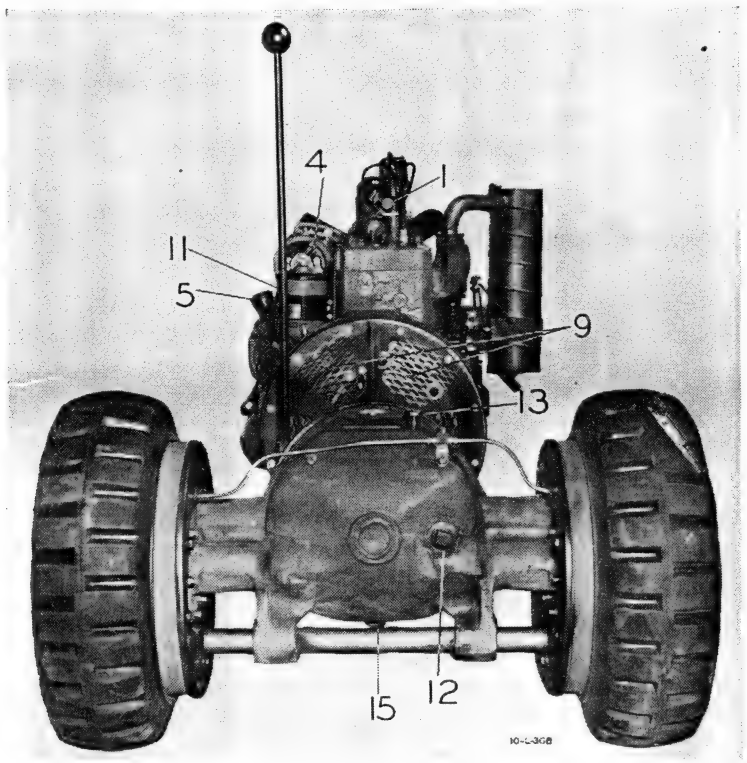

Fig. 4

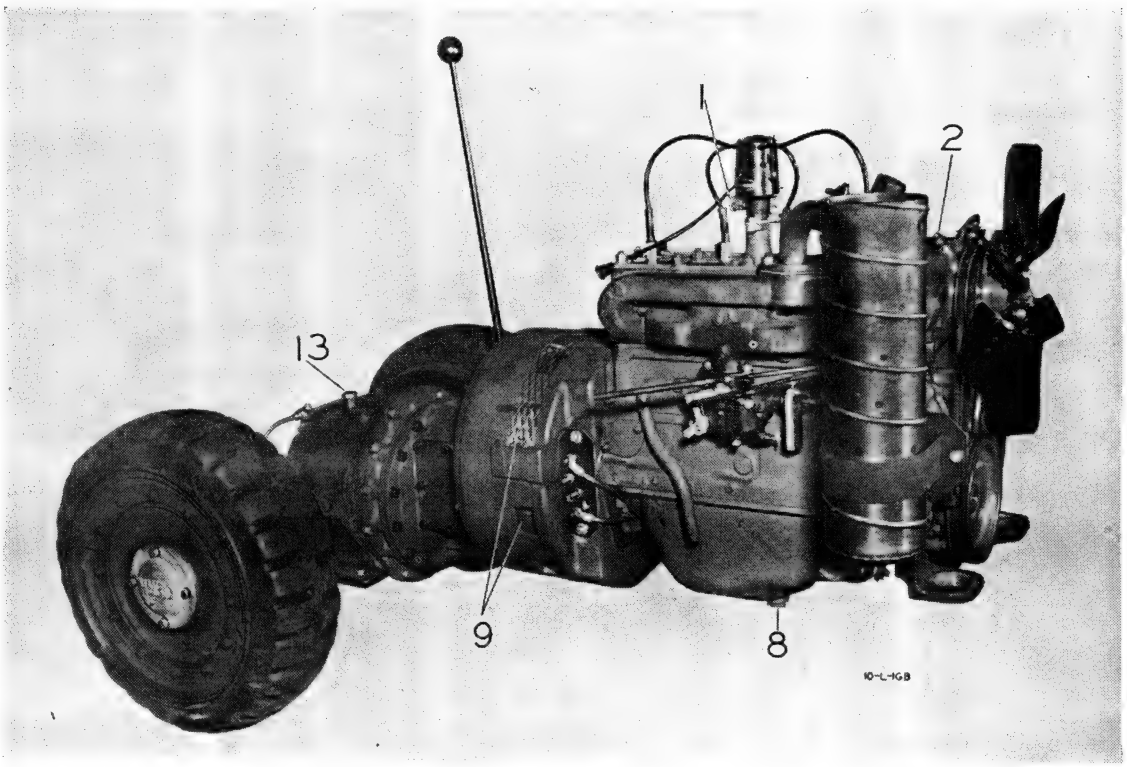

Fig. 5

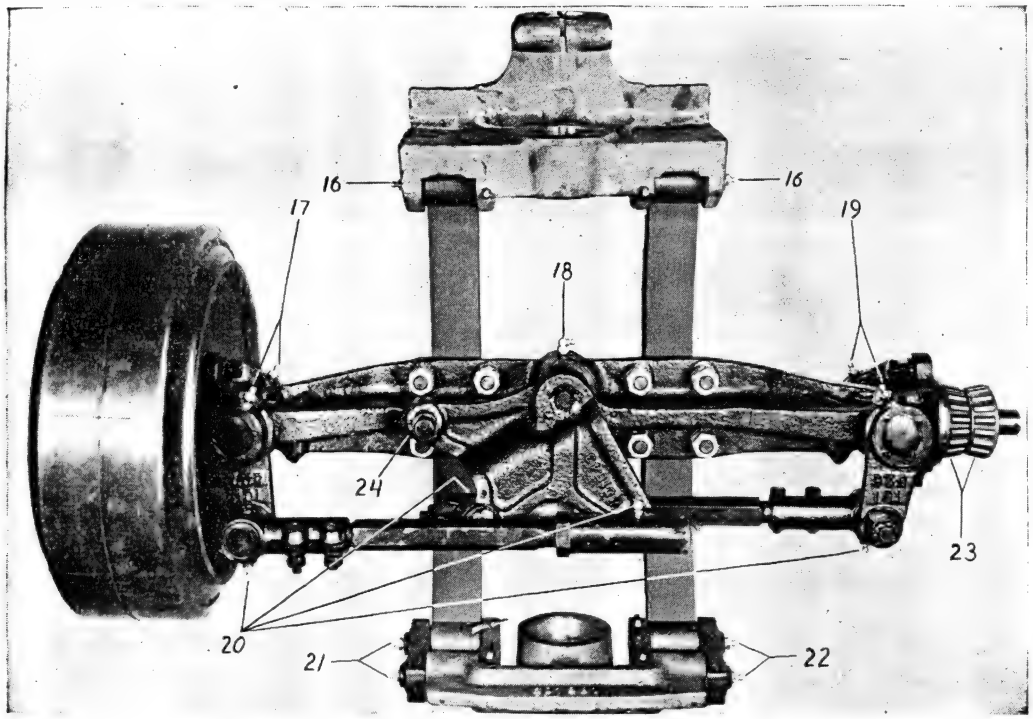

Fig. 6

9. **VENTILATED HOUSING:** Clean out with forced air each 40 operating hours. At no time permit screen to become clogged.

10. **TRANSMISSION DRAIN PLUG:** Transmission should be drained and flushed out every 1000 operating hours.

11. **OIL FILTER CARTRIDGE:** Should be changed each time crankcase oil is changed. Clean bowl before replacing cartridge: (Refer to item No. 8.)

12. **TRANSMISSION AND DIFFERENTIAL:** Both are filled from plug in drive axle housing with SAE-90 transmission oil. Capacity is 12 pints. Transmission and differential are so arranged that transmission oil flows freely from differential to transmission when in motion. NOTE: After filling drive axle at No. 12, replace filler plug and drive machine for five minutes to work oil back into transmission. Then refill to plug level. Transmission oil should be checked every 40 operating hours.

13. **DRIVE AXLE AIR VENT:** Should be kept free from dust and lint at all times.

14. **MASTER BRAKE CYLINDER:** (Not Shown) Keep filled to ¼" of top with a good grade of hydraulic brake fluid.

15. **DIFFERENTIAL DRAIN PLUG:** Differential should be drained and flushed every 1000 operating hours and refilled with new oil in accordance with item No. 12.

16-21-22. **SPRING SHACKLES:** High pressure fittings. Two fittings on the rear and one on the front of each spring; total 6. Use semi-fluid chassis lubricant every 40 operating hours.

17-19. **STEERING AXLE SPINDLE PINS:**

High pressure fittings at top and bottom. Use semi-fluid chassis lubricant every 40 operating hours.

18. **STEERING AXLE CENTER PIVOT PIN:** High pressure fitting. Requires semi-fluid chassis lubricant every 40 operating hours.

20. **STEERING AXLE TIE RODS:** High pressure fittings at each end, total 4. Use semi-fluid chassis lubricant every 40 operating hours.

23. **STEERING WHEEL BEARINGS:** Pack with standard wheel bearing grease after removing wheels and washing bearings. Wash and repack every 1000 operating hours.

24. **DRAG LINK:** (Not Shown) High pressure fitting at each end, total 2. Use semi-fluid chassis lubricant every 40 operating hours.

25-26. **FRONT AND REAR PIVOT SUPPORT YOKES:** Equipped with high pressure fittings and require semi-fluid chassis lubricant every 40 operating hours.

GENERAL INSTRUCTIONS

UPRIGHT SUPPORT BUSHINGS: Both left and right are equipped with high pressure fittings. Use semi-fluid chassis lubricant every 40 operating hours.

UPRIGHT SLIDE BRACKET BEARINGS: Both left and right are equipped with four high pressure fittings and require semi-fluid chassis lubricant every 40 operating hours. Make certain thrust rollers operate freely.

INSIDE OF UPRIGHTS AND SLIDES: Clean entire slide assembly and coat with graphite paste every 40 operating hours.

LIFT AND TILT CONTROL LEVERS: Oil linkage with light oil every 40 operating hours.

HYDRAULIC OIL SUMP AND FILLER PIPE: Keep oil at a level that will leave 2 inches of oil in reservoir when forks are raised to a maximum height. Use a straight mineral oil of viscosity similar to SAE-10 engine oil, having a low pour point and non-foaming characteristics and containing oxidation and rust inhibitors.

RADIATOR: Always keep filled with water and protected with antifreeze during freezing weather. When draining radiator make sure the motor block is drained by opening drain cock on right hand side of motor. Check radiator daily. Capacity 14 quarts.

GAS TANK FILLER: Capacity of tank: 5 gallons.

LIFT CHAIN SPROCKET BEARINGS: High pressure fittings, total 2. Use semi-fluid chassis lubricant every 40 operating hours.

LIFT CHAINS: Lubricate with SAE-10 engine oil. Wipe chains every 40-50 operating hours and apply oil with 1″ brush.

TILT CYLINDER PIVOT PINS: Equipped with high pressure fittings, total 4. Use semi-fluid chassis grease every 40 operating hours.

LIFT CARRIAGE ROLLER PINS: (Not Shown) High pressure fittings, total 4. Require semi-fluid chassis lubricant every 40 operating hours.

STEERING GEAR HOUSING: Lubricate with SAE-140 steering gear lubricant every 40 operating hours in freezing temperatures and SAE-250 in warm temperatures.

AIR CLEANER: Clean and refill oil bath air cleaner cup daily, more frequently under extremely dusty conditions. Ordinary operating conditions require servicing element every 40 operating hours. Clean the filter element by immersing in a dry cleaning solvent and drying with compressed air. Refill to oil level with SAE-30 in summer temperatures and SAE-20 in winter temperatures.

BATTERY: Located under the hood. Plates must be covered ⅜″ with distilled water. Check battery every 120 operating hours. Clean terminals with ammonia and coat them with vaseline.

DRIVE AXLE SPUR GEARS: These gears are lubricated with a high grade lubricant during assembly at the factory and require no further lubrication during the life of the machine.

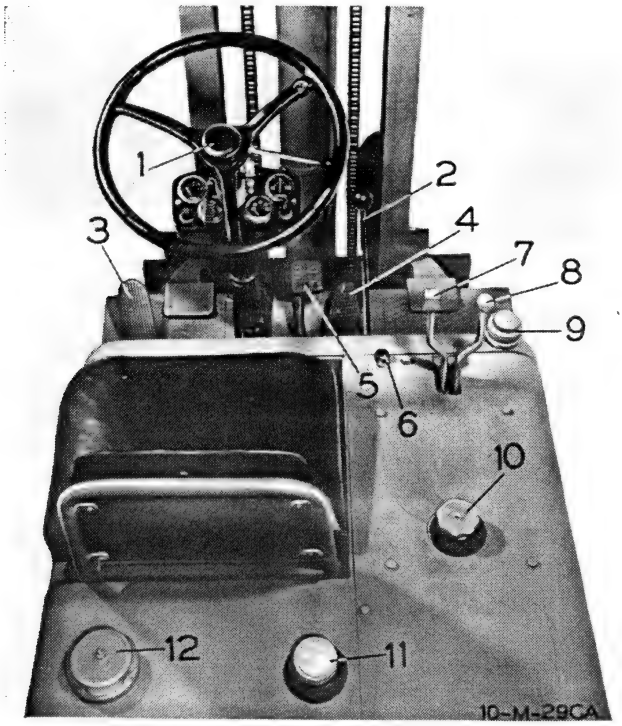

Fig. 7

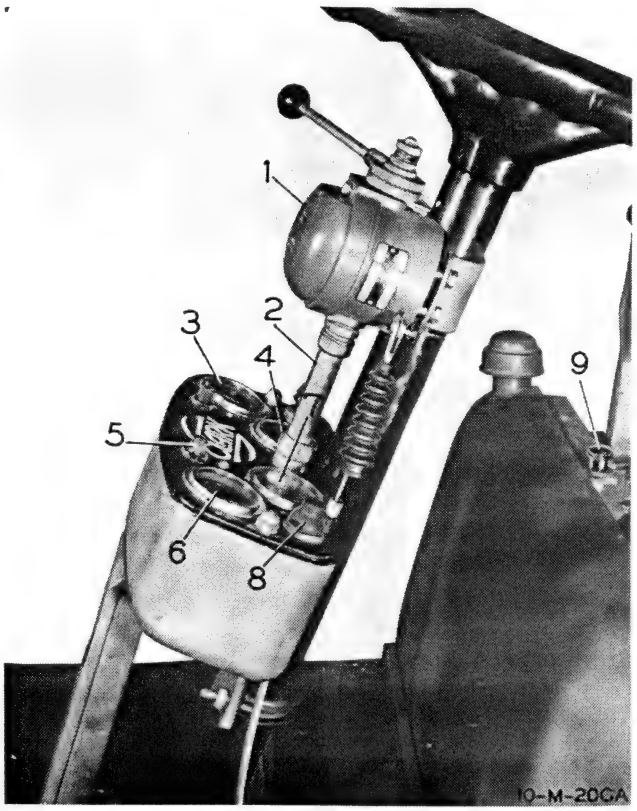

Fig. 8

LOCATION OF CONTROLS

DRIVING: (Refer to Fig. 7)

1. Horn button is located in the center of the hand steering wheel. Use the horn only when necessary.

2. Gear shift lever is located at the drivers right. This lever controls the low and high speed range of the transmission.

3. Caterpillar control pedal is located where the clutch pedal would normally be located. This pedal controls the flow of power to the Dynatork drive. This unit is installed in the system to allow the operator to "inch" the fork-lift truck.

4. Accelerator pedal located on floor board to operators right.

5. Brake pedal is operated with drivers right foot. Depressing the pedal will actuate the hydraulic brakes to slow and/or stop the fork-lift truck.

6. Choke button is located on the hood. Use it only when starting a cold engine.

7. Tilt control handle is operated by the drivers right hand. When tilt lever is moved to the rear, upright is tilted rearward. When lever is moved forward, upright is tilted forward.

8. Lift lever located at right of operator. The lift lever controls the lifting and lowering movement of the upright.

9. Sump tank filler cap is located at right hand side of hood.

10. Gas tank filler cap located at drivers right.

11. Radiator cap is located on the hood behind the driver.

LOCATION OF INSTRUMENTS (Refer to Fig. 8)

The instrument panel consists of the gas gauge (6), temperature gauge (7), ammeter (3), and oil pressure gauge (4).

The gas gauge shows the level of fuel in the tank. The temperature gauge indicates temperature of the water in the cooling system. Ammeter shows the rate of generator charge or battery discharge. Oil pressure gauge shows the pressure output of the engine oil pump.

NOTES

PART II

MAINTENANCE AND REPAIR

The following pages are devoted to maintenance and repair of this Clark truck. The book is divided into sections and each part deals with the servicing, removal, disassembly and installation to the machine and trouble shooting or diagnosis. The sections are arranged in alphabetical order for convenience in finding the required pages. The table of contents and index in the front of the manual provide further assistance in locating the desired phase of maintenance and repair.

NOTES

DRIVE AXLE ASSEMBLY

DESCRIPTION

The drive axle is of the full floating type. The drive wheels are mounted on the axle housing by two opposed tapered roller bearing locked in place with a sleeve type nut and spider lock ring. The entire weight of the machine is carried by the axle housing, therefore, the drive axle shafts serve only to drive the wheels. The axle shaft rides free or floats inside the axle housing. It is attached to the wheels by a flange forged on the axle shaft and cap screws to hold the flange to the drive wheels. Splines on the opposite end fit into splines of the differential side pinions.

The differential assembly is of the conventional bevel gear full floating construction carried by tapered roller bearings on the differential carrier and has two pinion gears with two side pinion gears.

DRIVE AXLE REMOVAL

With upright and floor plates removed, drain lubricant from drive axle, and proceed as follows:

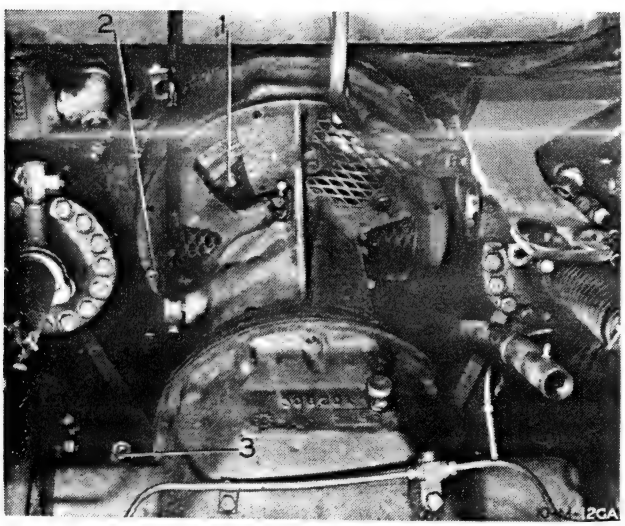

Fig. 9

1. Place blocking under frame behind drive wheels.

2. Place blocking under transmission case.

3. REMOVE COUNTERWEIGHT OR BLOCK IT SECURELY.

4. Disconnect brake line at Tee. Fig. 10, Ref. 4.

5. Using a chain hoist, support weight of drive axle assembly. See Fig. 11.

6. Remove thirteen bolts holding drive axle to transmission case. Fig. 9, Ref. 2.

7. Remove four bolts and nuts holding drive axle to frame. Fig. 9, Ref. 3.

8. Maneuver drive axle away from machine. See Figs. 12 and 13.

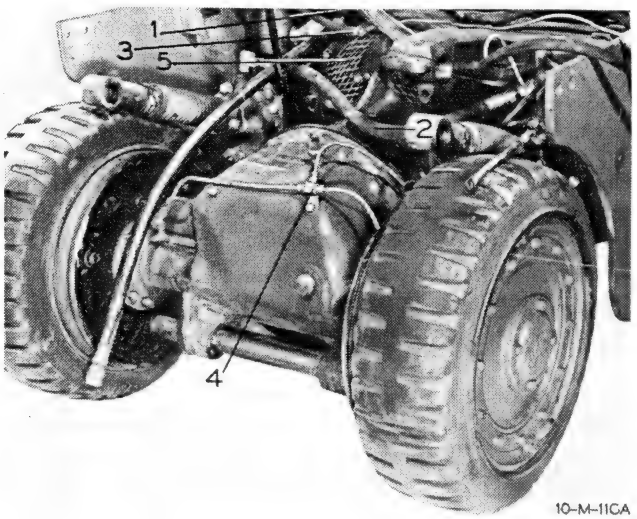

Fig. 10

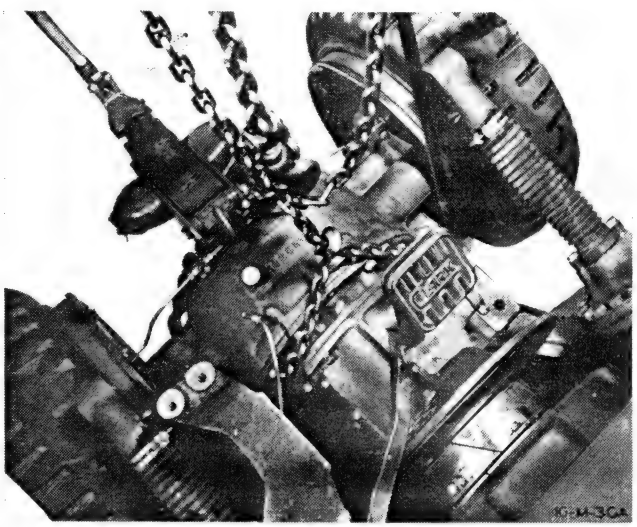

Fig. 11

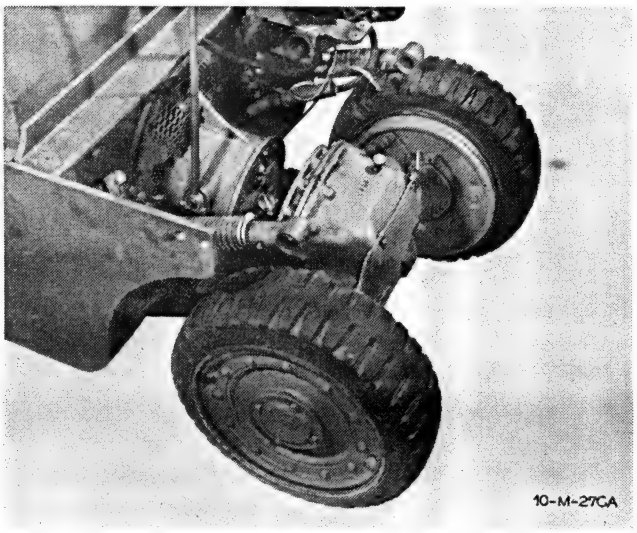

Fig. 12

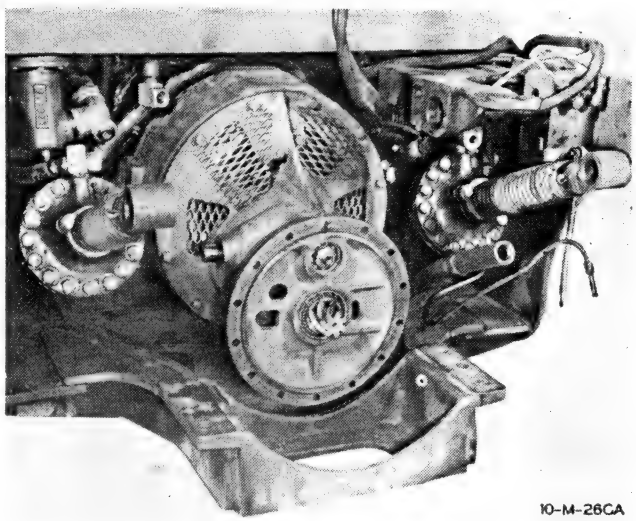

Fig. 13

DRIVE AXLE DISASSEMBLY

A. After removal from vehicle:

1. Drain all lubricant.

2. Clean exterior of assembly thoroughly.

B. Back-off brake adjustment to full release position.

C. Remove hub cap capscrews and remove hub cap.

D. Remove cotter from wheel bearing adjusting nut, then with proper wrench, remove adjusting nut.

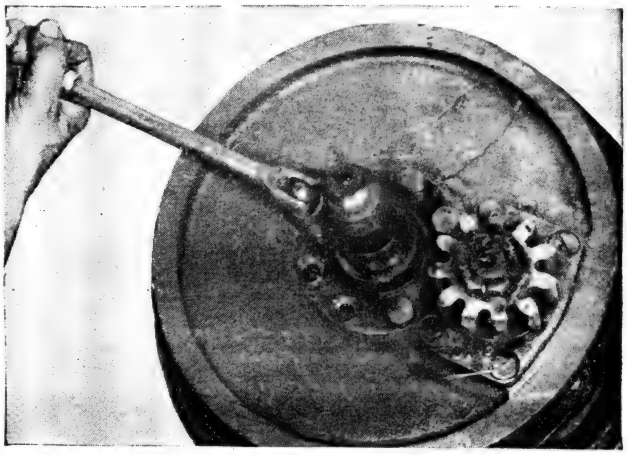

Fig. 14

E. Remove thrust washer and outer bearing cone, then remove from assembly.

F. Pull inner bearing cone and grease retaining washer from axle shaft.

G. 1. Cut and remove lockwire from wheel disc screws; then with proper wrench, remove the screws.

2. Complete disc, drive pinion and drive shaft assembly may now be removed from axle. See Fig. 14.

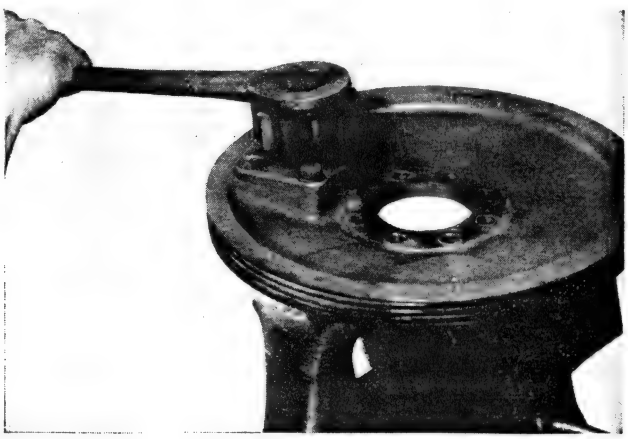

Fig. 15

H. Remove drive shaft from disc as follows:

1. Remove cotter key and drive shaft nut. (Refer to Fig. 15.)

2. Pull gear from shaft.

3. Remove two slotted screws and two hex-head capscrews from bearing retainer. (Refer to Fig. 16.)

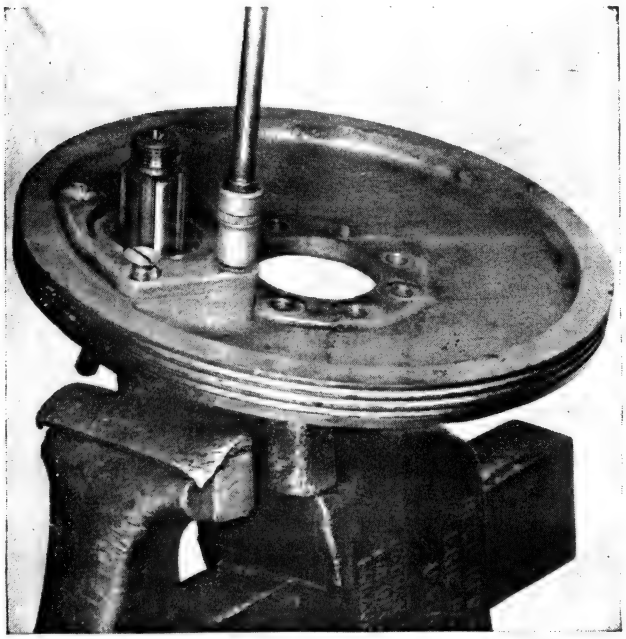

Fig. 16

4. Pressing on differential end of shaft, remove shaft and bearing from disc. (Refer to Fig. 17.)

5. Bearing may be pressed from shaft, for replacement.

6. Oil seals may be pressed from disc, (Refer to Fig. 18) and from bearing retainer.

I. Brake shoes are removed as follows:

1. Unhook and remove return spring.

2. Remove anchor pin "C" washers and guide pin "C" washers. (Refer to Fig. 19.)

3. Remove guide pin plain washers.

4. Brake shoe assembly may be removed from anchor pins for replacement of lining or bushing.

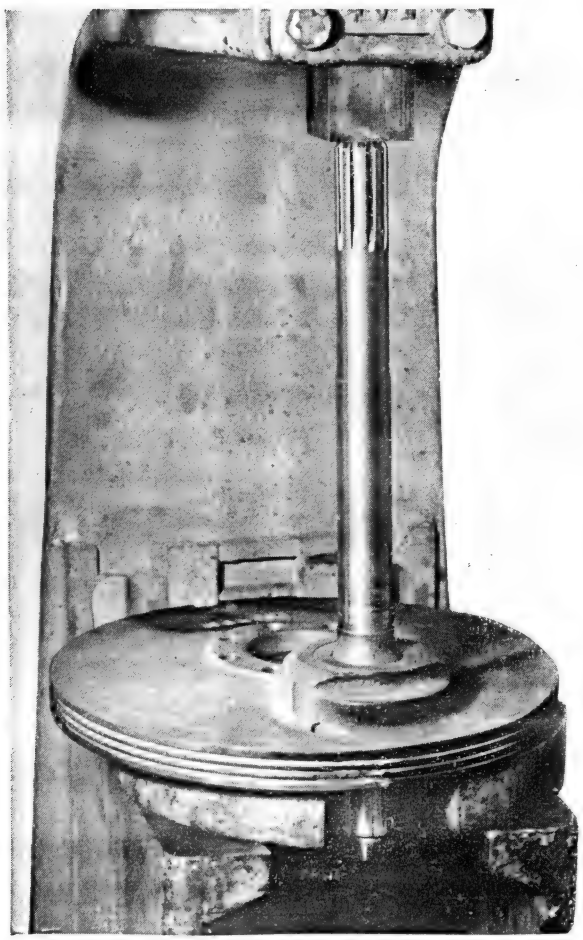

Fig. 17

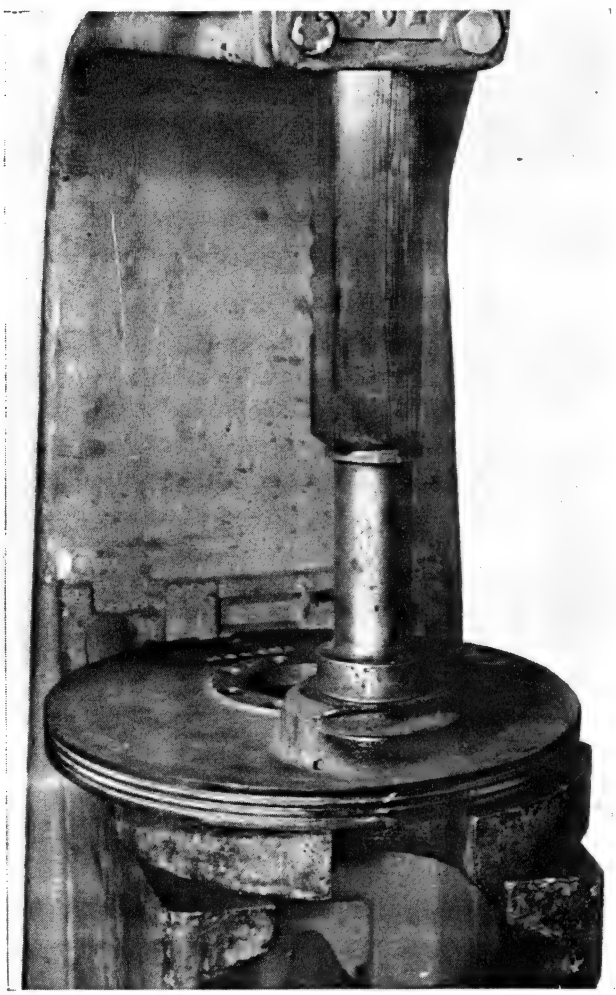

Fig. 18

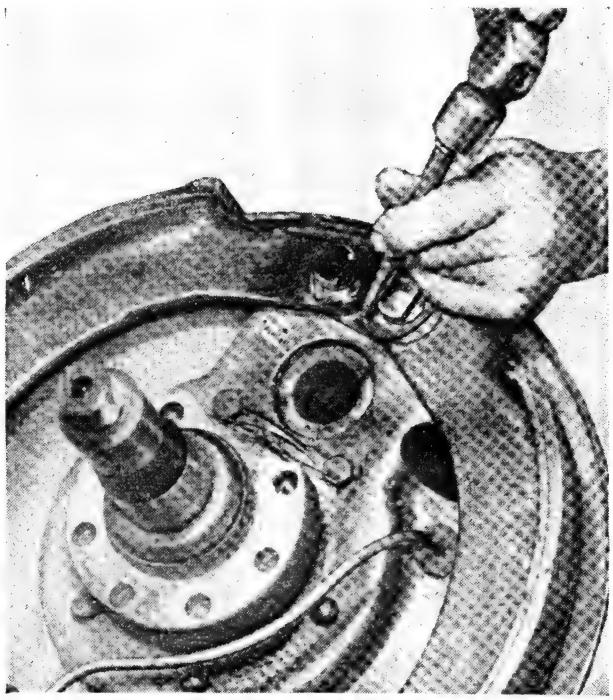

Fig. 19

DIFFERENTIAL DISASSEMBLY
(Refer to Fig. 22)

With both drive axle shafts removed, proceed as follows:

Remove the thirteen hex head cap screws that hold the differential assembly to axle housing and separate differential from axle housing. Fig. 20, Ref. 1.

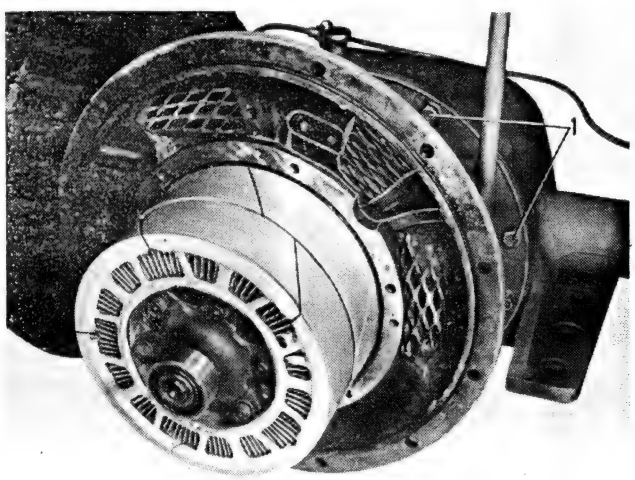

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Fig. 20

Remove the four hex head screws that hold the bearing cage to differential housing (2).

Take off the bearing cages (1) and bearing cup (5).

Note the shims under the bearing cage. These adjust the backlash between the ring gear and drive pinion. Wire these shims to their respective cages and mark cages as to which side they were removed from.

Separate the differential gear case from the housing.

With a gear puller, pull the bearings off the differential gear case. Tag each bearing so that it can be replaced on the current side of the differential gear case.

With a punch drive the differential pinion pin lock pin (14) from the differential gear case. With a soft drive bar drive the pinion out of the differential gear case. Remove the differential pinions and thrust washers from case. Remove the side pinions and thrust washers.

NOTE: DO NOT remove the ring gear from the differential case unless replacement is necessary. If it is necessary to replace the ring gear be sure to put in a matched set consisting of ring gear and drive pinion. The ring gear is held to differential case by rivets.

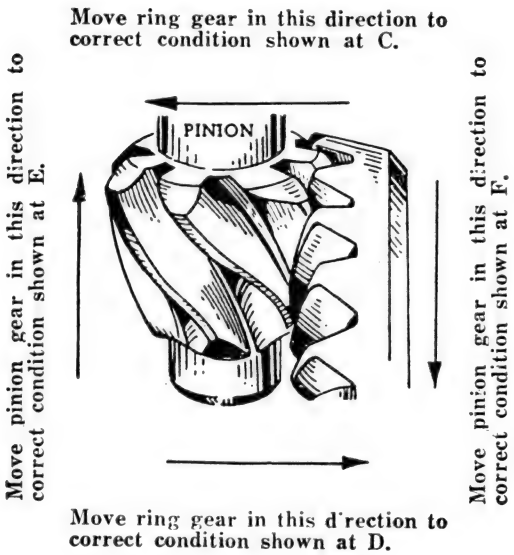
INSTRUCTIONS

1. With diffrential pinion assembly and differential assembly installed in carrier adjust pinion gear and ring gear for proper backlash as directed in "Adjustments" paragraph of this section.

2. Paint three or four teeth of pinion gear with red lead or mechanics' blue and rotate pinion gear until ring gear makes complete revolution.

3. Note area of tooth contact on ring gear which should start at toe and extend about 80 per cent of tooth length toward heel, as at B.

4. Vary position of pinion gear and ring gear as per chart until proper tooth contact is obtained. Be sure that sufficient backlash has been allowed so that ring gear can be completely revolved without any high spots being felt.



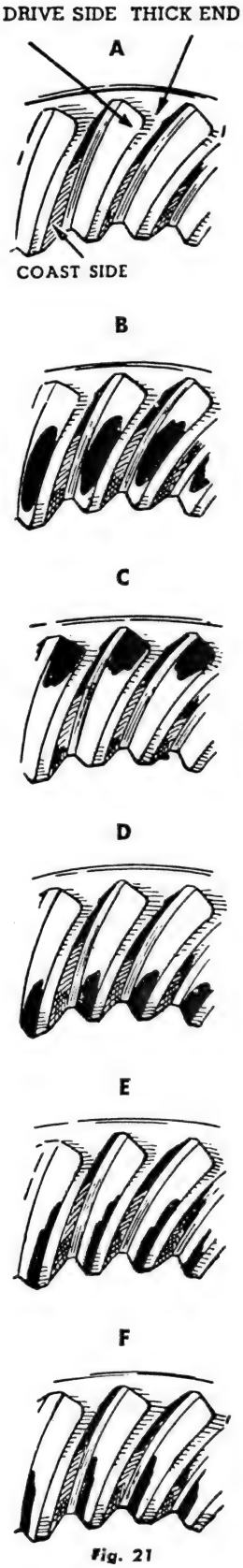


Fig. 21

A. Check adjustments at drive side of ring gear tooth.

B. Shows correct tooth contact.

C. Shows short contact at heel. To correct, move ring gear toward pinion gear. Then move pinion gear away from ring gear to again secure correct backlash.

D. Shows short contact at toe. To correct, move ring gear away from pinion gear. Then move pinion gear toward ring gear to again secure correct backlash.

E. Shows heavy contact on flank or lower portion of tooth. To correct, move pinion gear away from ring gear until contact comes to full working depth of ring gear tooth without breaking contact at flank. Then move ring gear toward pinion gear to secure correct backlash.

F. Shows heavy contact on face or upper portion of tooth. To correct move pinion gear toward ring gear until contact covers flank of tooth without breaking contact at face. Then move ring gear away from pinion gear to secure correct backlash.

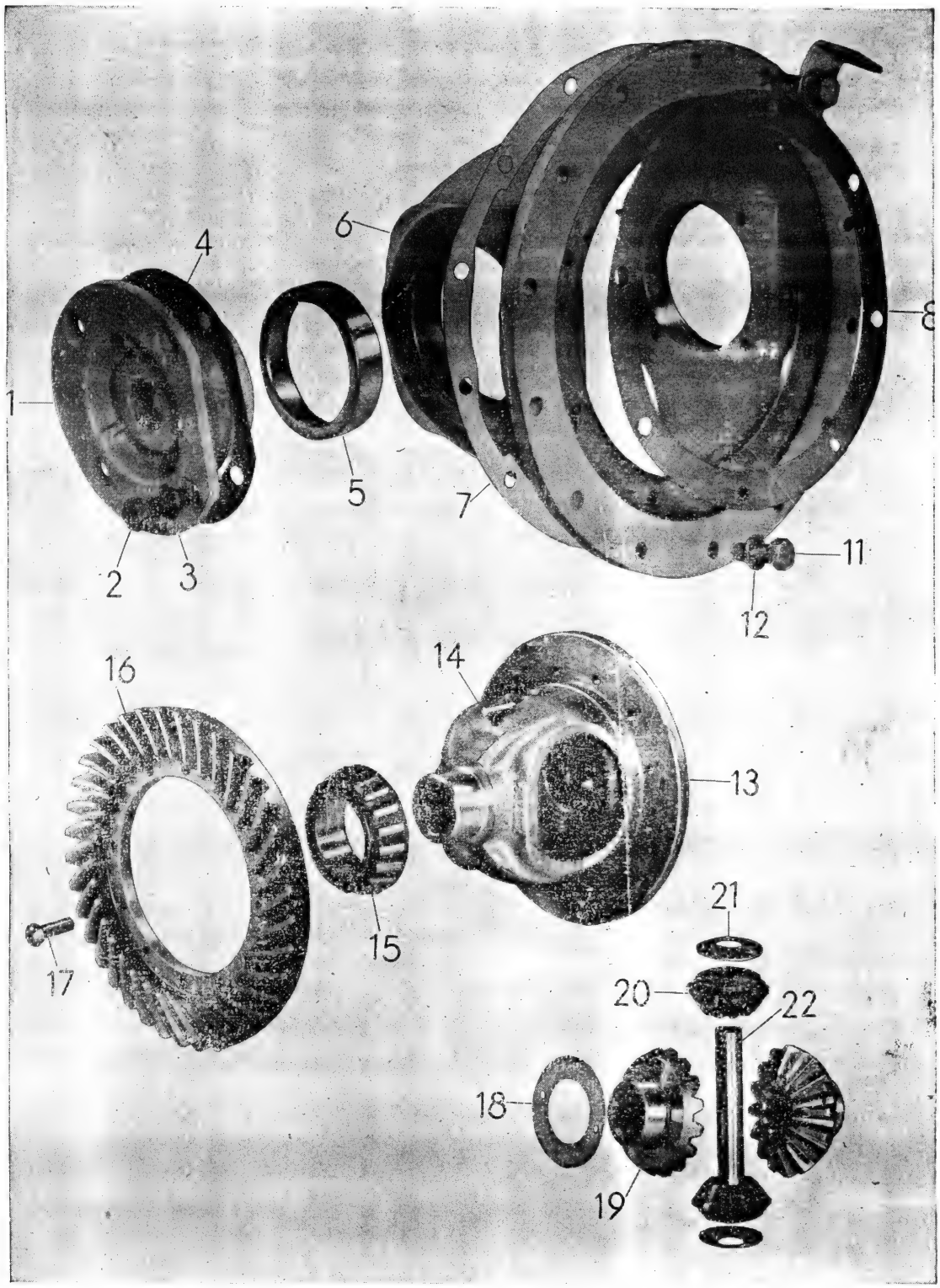


Fig. 22

MAINTENANCE AND INSPECTION

Clean all parts of the differential in a clean solvent. Dry with filtered compressed air. NOTE: Clean the differential case bearings in separate cleaning solution. Dry the bearings with filtered compressed air. Be sure the bearings do not spin while drying.

Roll the bearing by hand checking for high or rough spots in the race.

Inspect all gears for scored places, pitts or burrs on the face of the teeth. Remove small burrs with a fine stone, removing only the raised edge of the burr. Replace the gear if it is badly burred or scored.

When the differential is dismantled for repairs it is advisable to replace gaskets and oil seals to insure against oil leaks. Always use new cotter keys when overhauling a unit.

Lubricate all parts of the differential with gear oil before reassembly and be sure all parts are free of foreign material.

ADJUSTMENT OF RING GEAR AND DRIVE PINION

INSTRUCTIONS

1. With differential pinion and ring gear assembly and differential assembly installed, adjust pinion gear and ring gear for proper backlash as directed in the following paragraphs of this section.

2. Paint three or four teeth of pinion gear with read lead or mechanic's blue and rotate pinion gear until ring gear makes complete revolution.

3. Note area of tooth contact on ring gear which should start at toes and extend about 80 per cent of tooth length toward heel, as at B, Fig. 21.

4. Vary position of pinion gear and ring gear as per chart until proper tooth contact is obtained. Be sure the sufficient backlash has been allowed so that ring gear can be completely revolved without any high spots being felt.

A. Check adjustments at drive side of ring gear tooth.

B. Shows correct tooth contact.

C. Show short contact at heel to correct, move ring gear toward pinion gear. Then move pinion gear away from ring gear to again secure correct backlash.

D. Show short contact at toe. To correct, move ring gear away from pinion gear. Then move pinion gear toward ring gear to again secure correct backlash.

E. Shows heavy contact on flank or lower portion of tooth. To correct, move pinion gear away from ring gear until contact comes to full working depth of ring gear tooth without breaking contact at flank. Then move ring gear toward pinion gear to secure the correct backlash.

F. Shows heavy contact on face or upper portion of tooth. To correct, move pinion gear toward ring gear until contact covers flank of tooth without breaking contact at face. Then move ring gear away from pinion gear to secure correct backlash.

DIFFERENTIAL REASSEMBLY. (See Fig. 22)

Place the thrust washers over the side pinions and place pinions in differential case.

Slide the differential pinions thrust washers into place, meshing teeth in the pinions. Line up the pinion pin holes and drive the pinion pin into place. Lock pinion pin to differential gear case with the lock pin.

Press the right differential case bearing on the seat of the differential case. Press the left differential case bearing on the seat of the differential case. Maneuver the differential case back into the differential housing.

Slip the bearing cups on the bearings, fit the bearing case and shims over the bearing cup. Pull the four cap screws up tight. NOTE: Be sure to install the bearing cup, cages, and shims on the same side from which they were removed.

It is necessary to adjust the backlash between the ring gear and pinion before installing the differential assembly on the axle housing.

DRIVE AXLE REASSEMBLY

A. Assemble brake shoes to disc assembly as follows:

1. Install guide pin plain washers on guide pins.

2. Coat anchor pins with light film of grease, and install brake shoes on anchor pins and guide pins.

3. Place guide pin plain washers in position, and install and clinch guide pin "C" washers.

4. Install and clinch anchor pin "C" washers.

5. Hook brake return spring.

B. Reassemble wheel disc as follows:

1. Press oil seal into disc (Refer to Fig. 18) with lip of seal toward bearing bore.

2. Press bearing into disc.

3. Press seal into bearing retainer then install retainer on disc and secure in place with two hex-head capscrews and two slotted screws.

4. Install shaft in bearing, from rear of disc.

5. Install gear on shaft and draw up solidly with drive shaft nut. (Refer to Fig. 15.)

6. Insert cotter key and spread.

C. Install wheel disc and shaft assembly and secure in place with capscrews. (Refer to Fig. 14.)

D. Install lockwire in screws to prevent loosening. Install gear shaft.

E. Install grease retaining washer, on axle shaft, then inner wheel bearing cone.

F. Install wheel assembly on axle shaft and entering gear teeth simultaneously.

G. Install in order, the outer bearing cone, thrust washer, and adjusting nut.

H. With proper wrench, tighten nut solidly while rotating the wheel, to insure proper seating of bearings. Back off adjusting nut approximately one-sixth of a turn and install cotter key and spread.

I. Install hub grease cap and secure in place with capscrews and lockwashers.

DRIVE AXLE INSTALLATION

1. Using a chain hoist, position drive axle to machine.

2. Install new gasket, and bolt drive axle to transmission case with thirteen bolts. Tighten bolts alternately.

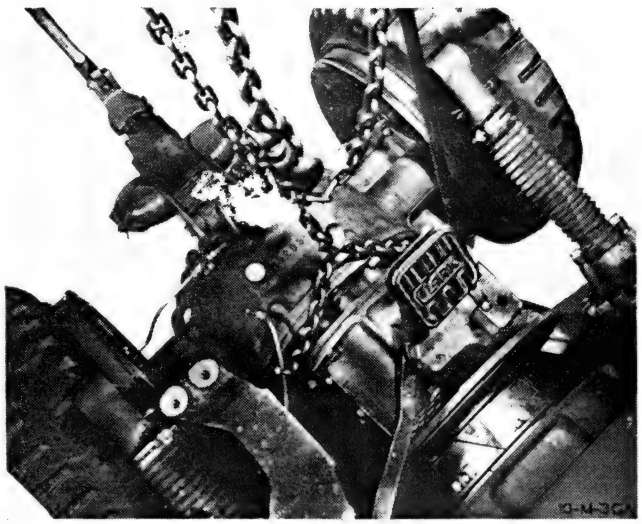


Fig. 23

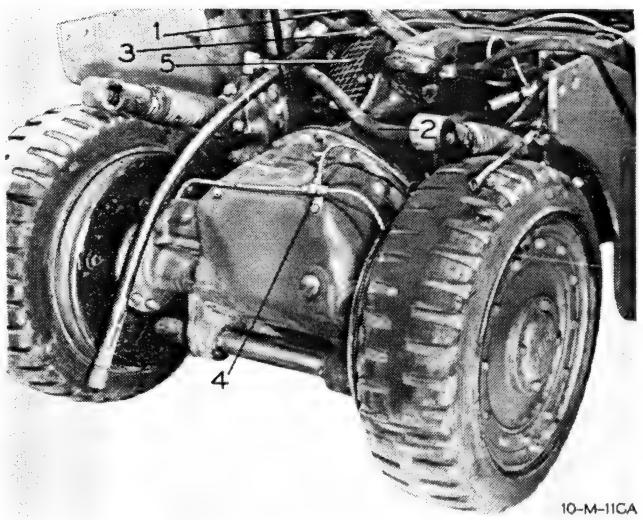


Fig. 24

3. Bolt drive axle to frame with four bolts and nuts.

4. Remove chain hoist and connect brake line at Tee.

5. Replace upright assembly and floor plates.

6. Fill drive axle with proper lubricant. See "Lubrication Instructions."

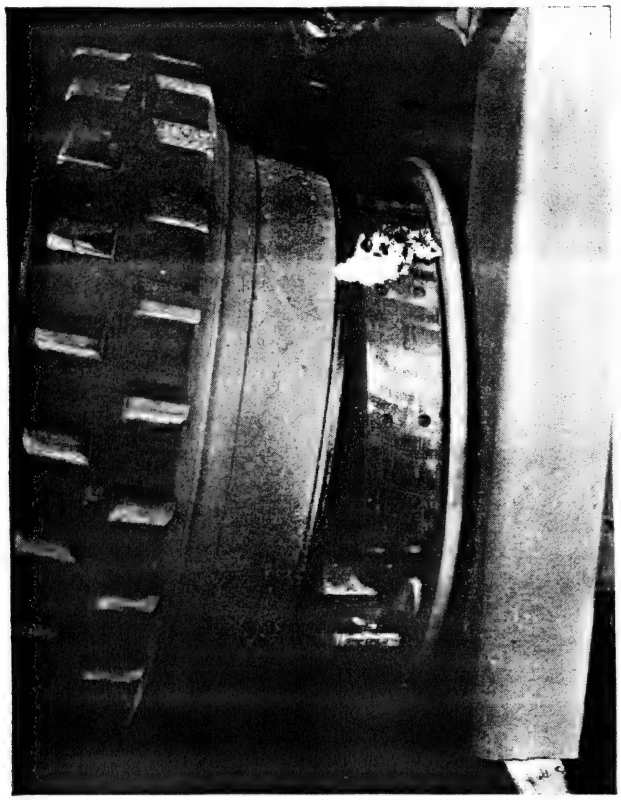


Fig. 25

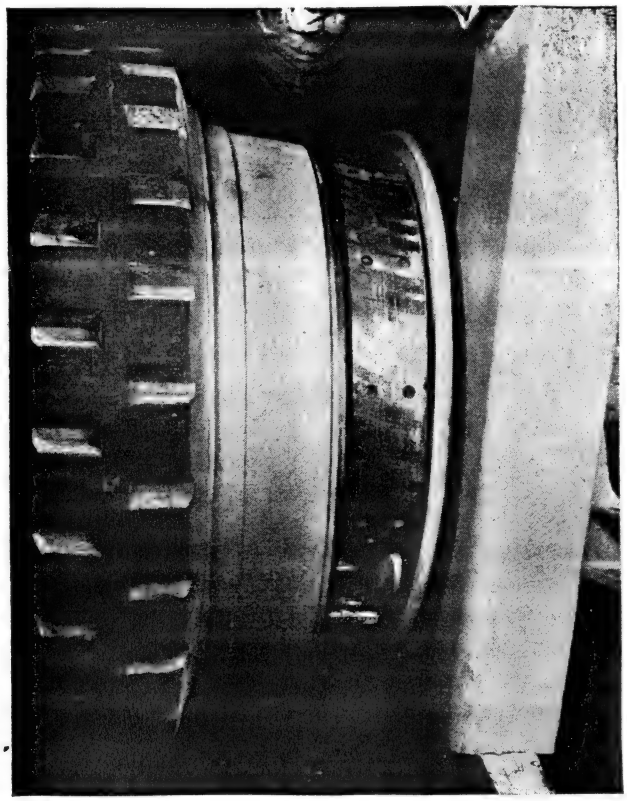


Fig. 26

DRIVE WHEEL INSTALLATION

1. Roll wheel in mounting position.
2. Tilt upper portion of brake drum over dust shield.
3. Tilt upright forward until wheel reaches perpendicular position on floor.
4. Tilt upright back until upper portion of drum can be pushed over brake shoe.
5. Tilt forward until wheel squares itself and revolve wheel to line up spur and ring gear.
6. Push wheel on and install bearing and spacer washer.
7. Install wheel nut and tighten and back off one castellation and insert cotter pin.
8. Replace hub cap and cap screws.
9. Readjust brake cams for proper brake adjustment.

DRIVE AXLE TROUBLE SHOOTING GUIDE

Some noise can be expected from the drive axle and motor assembly. The natural noise from the drive motor and gear train must be interpreted to be something wrong in the assembly. Determine first if the noise is unusual and not the normal noise of the motor.

CONTINUOUS AXLE NOISE
CAUSES

1. Improper adjusted wheel bearings
2. Worn or improperly adjusted differential pinion gears.
3. Worn differential bearings.
4. Insufficient lubricant.

AXLE NOISE ON DRIVE OR COAST ONLY
CAUSES

1. Worn ring gear and pinion gear.
2. Ring gear and drive pinion out of adjustment.

EXCESSIVE BACKLASH IN DIFFERENTIAL
CAUSES

1. Ring gear and pinion out of adjustment.
2. Differential pinion gears worn.
3. Drive axle shaft splines worn.
4. Loose Motor Mounting Flanges

FAILURE TO FUNCTION
CAUSES

1. Broken drive axle shaft.
2. Broken teeth on ring gear.

NOTES

STEERING AXLE

REMOVE COMPLETE STEERING PIVOTED AXLE

To remove complete steering pivoted axle use the following instructions:

1. Using chain hoist and proper counterweight hook, remove four counterweight bolts and remove counterweight.

2. Raise rear of machine and block at frame cross member.

3. Remove steering wheels and tires.

4. Remove drag link assembly from center steering arm.

5. Remove cotter pin from pivot yoke rocker arm support pin.

6. Turn steering assembly to extreme right position and drive pivot yoke rocker arm support pin forward toward axle to remove.

7. Lower rear of assembly, remove front pivot yoke rocker arm stud nut, lockwasher and washer and remove assembly from machine.

INSTALL COMPLETE PIVOTED AXLE

1. Install front pivot yoke rocker arm assembly on pivot yoke stud and secure with washer, lockwasher and nut.

2. Install rear pivot yoke rocker arm assembly in cross member. Align holes and insert pivot yoke rocker arm support pin from the rear; lock in position with new cotter pin.

3. Install drag link to steering arm assembly.

4. Install steering wheels and tires making sure to repack wheel bearings with wheel bearing grease.

5. Install counterweight. NOTE: Use the same shims between frame and counterweight that were disassembled and in same locations.

REMOVE AXLE ONLY

1. Raise the rear end of the machine and block up for safety. Remove four cap screws holding hub cap. Remove cotter pin from wheel, and remove nut.

2. Remove outer wheel bearing and slide steering wheel from spindle.

3. Disconnect the drag link ball by removing the cotter pin and ball cap from the drag link at the steering arm.

4. Remove the axle "U" bolt nuts from the spring "U" bolts. Remove bolts. (Fig. 27.)

5. The axle can then be pulled from the side of the machine. (Fig. 28.)

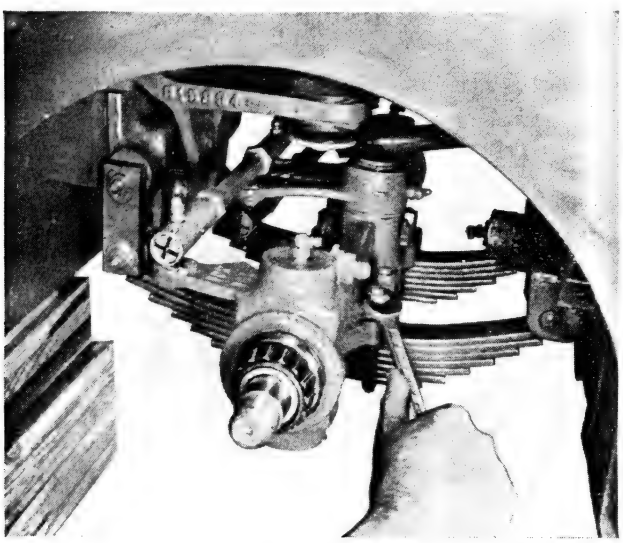


Fig. 27

Fig. 28

INSTALL AXLE ONLY

1. Position axle to springs.

2. Install "U" bolts and nuts. Do not tighten nuts until all "U" bolts are in position.

3. Tighten nuts and install jam nuts.

4. Install drag link to steering arm. Install ball cap and cotter pin. Adjustment of drag link should be secure but not so tight as to bind and cause hard steering.

5. Install steering wheels and bearings. Clean and pack bearings with wheel bearing grease before installation.

6. Install nut and cotter pin to axle spindle to secure wheel. Tighten sufficiently to allow free turning of wheel without binding or looseness.

7. Install hub caps and secure with cap screws.

8. Lubricate all fittings.

TOE-IN ADJUSTMENT

The steering wheels of the machine are designed to be adjusted parallel without toe-in. Adjustment should be made in the following manner:

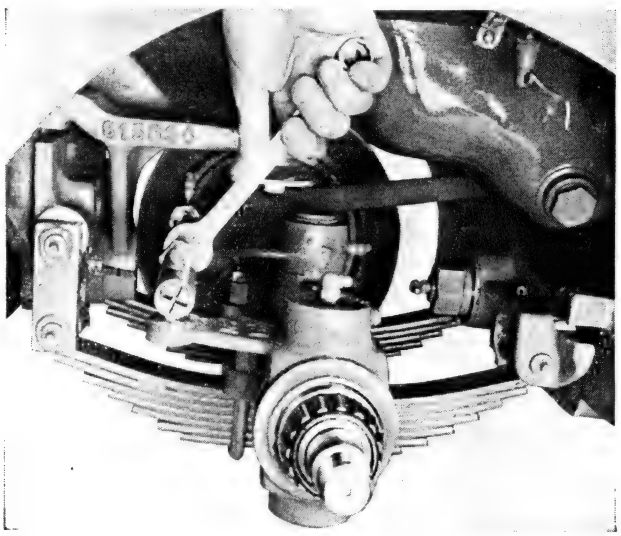


Fig. 29

1. Set steering hand wheel in exact center position. This will locate worm and sector at high spot in steering gear.

2. With drag link ball sockets properly adjusted, loosen tie rod ball socket lock nuts and adjust tie rods until both wheels are parallel, making sure to retain steering gear in center position during adjustment. (Fig. 29.)

TURNING RADIUS ADJUSTMENT

1. Loosen lock nuts on turning radius adjusting screws. (Fig. 30.)

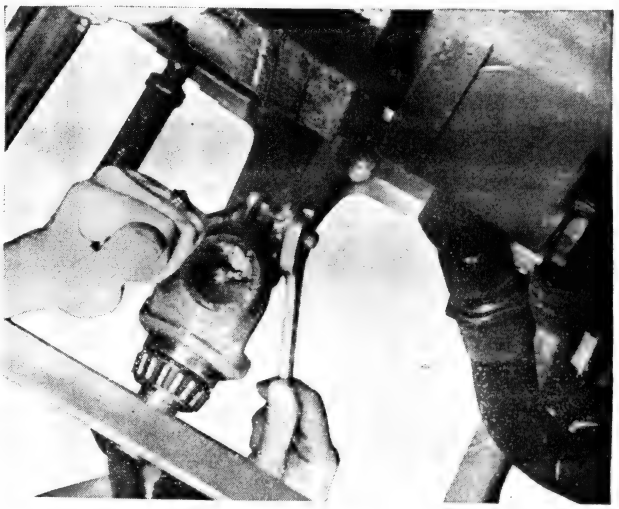


Fig. 30

2. Turn adjusting screws to desired setting, making sure spindles strike stops before steering gear worm strikes bearing in gear. The steering wheel should have one-half turn beyond point where spindles strike axle stops.

3. Tighten lock nuts securely.

NOTE

See Steering Gear Adjustments.

STEERING WHEEL REMOVAL

1. Remove rear or steering wheels by raising up end of machine with a hoist or the right type of hydraulic jack.

2. As a precaution put blocks under the axle at this time to support the weight.

3. Remove four cap screws holding hub cap to wheel and remove hub cap, cotter pin and nut and plain washer. See Fig. 31.

4. Shake wheel on spindle to loosen outer bearing and slide wheel off spindle.

NOTE: Steering wheel bearings are tapered roller bearing designed for end trust and roll. The cups are a press fit in the wheel but can be driven out with a hammer and drift punch.

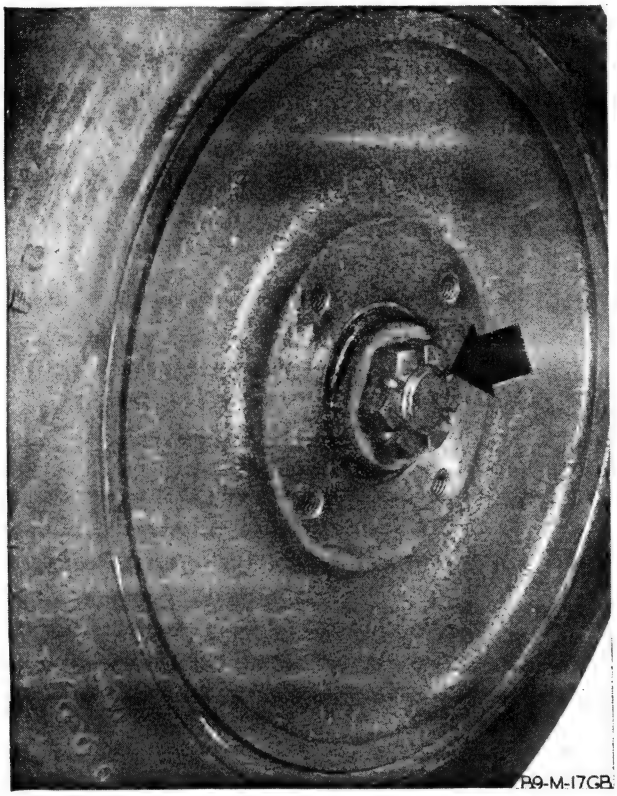


Fig. 31

STEERING WHEEL INSTALLATION

1. To install steering wheels put inner bearing on spindle and slide wheel on spindle.

2. Slide outer bearing on spindle.

3. Install flat washer and tighten nut then back off one castellation and cotter pin.

4. Install hub cap with four cap screws.

5. Remove blocking and lower machine to floor.

STEERING AXLE DISASSEMBLY

A. After removal from vehicle:

1. Clean exterior thoroughly.

B. Remove hub grease cap screws and remove cap.

C. Remove, in order, the knuckle cotter, nut, washer, and outer wheel bearing cone. Wheel assembly may now be pulled from axle. If wheel bearings are to be replaced, the cups may be pulled from the wheel hub.

D. Pull inner wheel bearing cone from knuckle.

E. Remove tie rod assemblies from steering knuckles and steering arm.

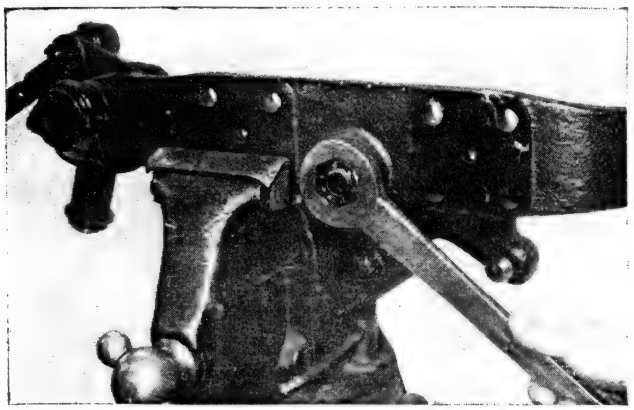


Fig. 32

F. Remove cotter from steering arm pin and with proper wrench remove steering arm pin nut. (Refer to Fig. 32.) Steering arm and pin assembly may now be removed from axle center. (Refer to Fig. 33.) Caution should be exercised so that thrust washers are not lost during this operation.

G. Using proper wrench, remove steering knuckle pin draw key nut, then remove lockwasher, and drive draw key from the axle center. (Refer to Fig. 34.)

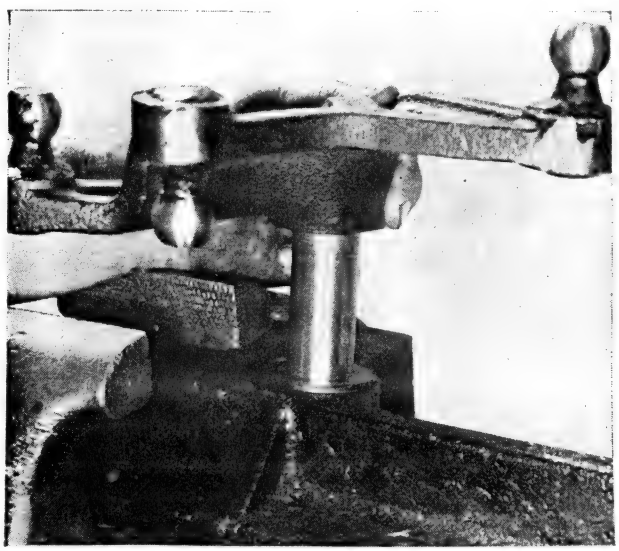


Fig. 33

H. Remove steering knuckle expansion plug from one end of knuckle, and press knuckle pin from assembly. (Refer to Fig. 35.) The expansion plug on opposite end of pin will be removed as pin is pressed through.

I. Remove knuckles from axle center, being careful not to drop the thrust bearing.

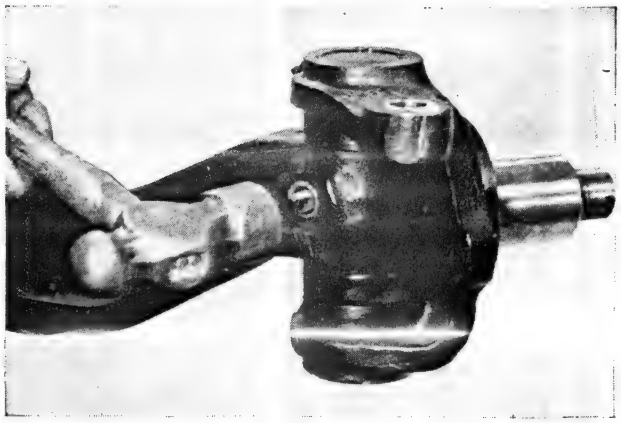


Fig. 34

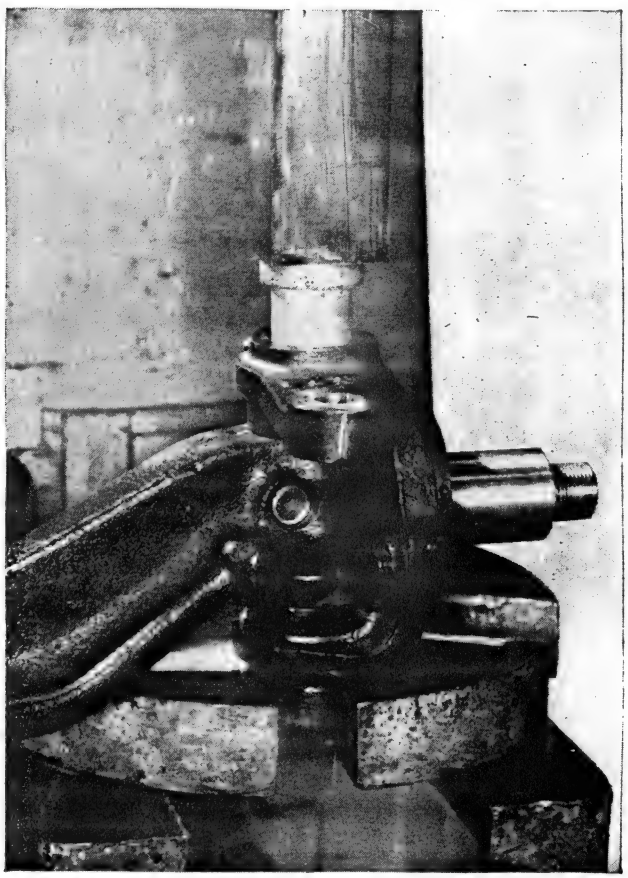


Fig. 35

J. Steering knuckle bearings may be pressed from knuckle for replacement.

K. If axle center bearing should warrant replacement, (Refer to Fig. 36) they may be pressed from the axle center.

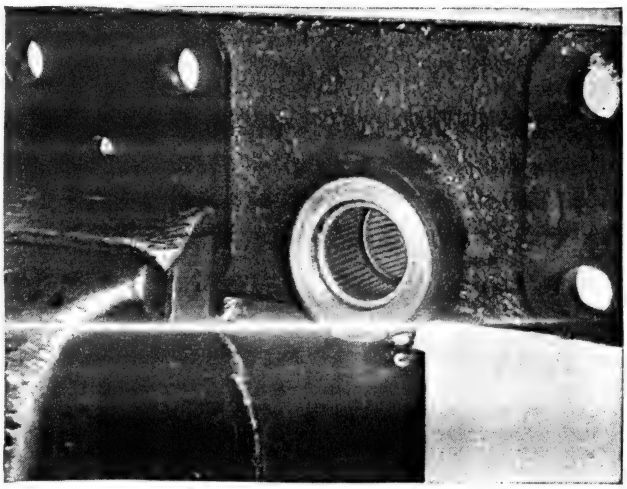


Fig. 36

STEERING AXLE REASSEMBLY

A. Press axle center bearings into axle center.

B. Press bearings into steering knuckles.

C. Holding thrust bearing in position, place steering knuckle on axle center and align pin holes.

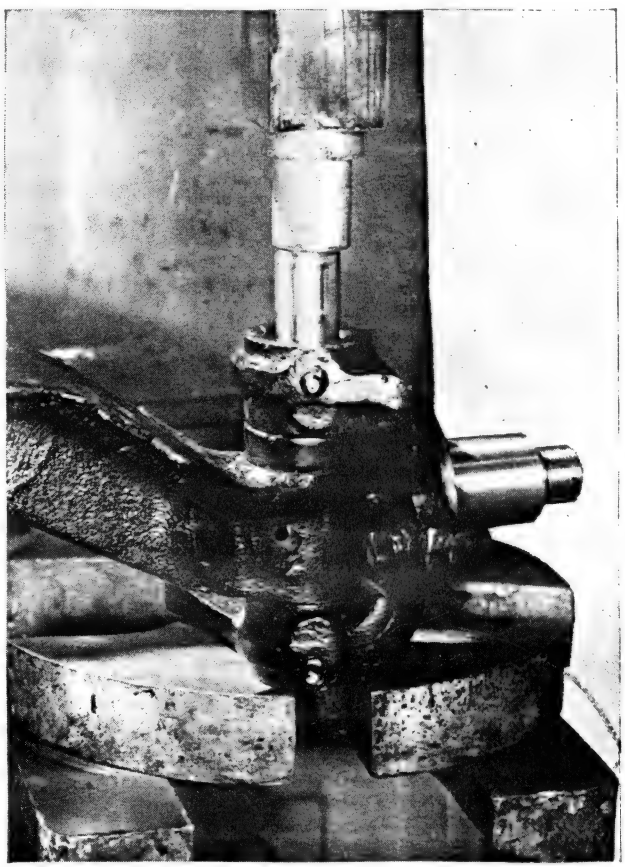


Fig. 37

D. Press steering knuckle pin into place, being certain that slot in pin aligns with hole in axle center for draw key. (Refer to Fig. 37.)

E. Install draw key and secure in place with nut and lockwasher.

F. Install expansion plugs in steering knuckle and with proper tool, "set" solidly to hold them in

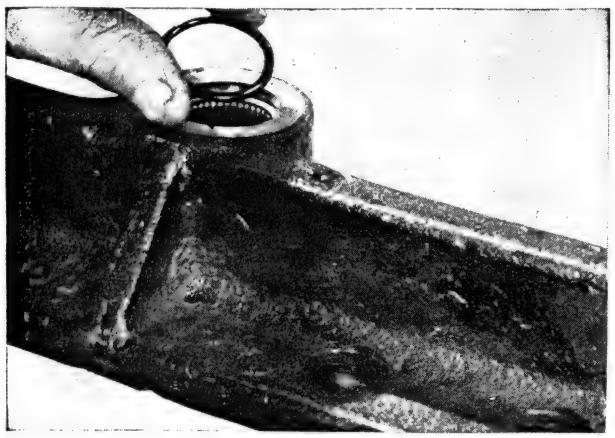


Fig. 38

place. It is important that the plugs be tight as they are the needed protection against dirt and other foreign matter entering the knuckle bearings.

G. Install "O" ring seal above upper axle center bearing, (Refer to Fig. 38) then holding thrust washer in position, insert steering arm pin through axle center, and install lower "O" ring seal and lower thrust washer.

H. Install nut on steering arm pin and with proper wrench tighten solidly. (Refer to Fig. 32.)

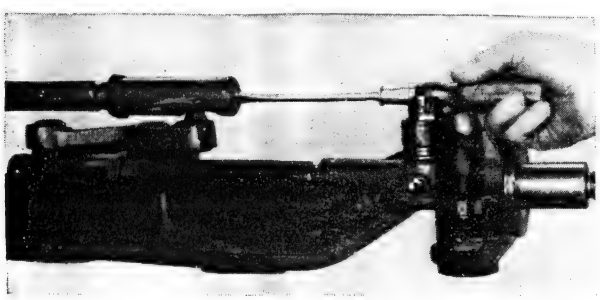


Fig. 39

Back nut off to first notch and insert cotter key and spread.

I. Install tie rod assemblies on steering knuckles and secure in place with ball bolt nut and cotter.

J. Install opposite ends of tie rods on steering arm ball bolts and tighten adjusting cup solidly, then back-off adjusting cup to first position that cotter key can be inserted. Insert cotter and spread. (Refer to Fig. 39.)

K. Install inner wheel bearing cone on knuckle. (All wheel bearing cones should be packed with a good grade of wheel bearing grease.)

L. Press wheel bearing cups into wheel and install grease seal if same had been removed.

M. Install, on knuckle in order, the wheel, outer bearing cone, thrust washer, and adjusting nut.

N. Tighten adjusting nut, while spinning the wheel, to seat bearings properly. As soon as wheel does not turn freely, back-off nut one-sixth turn or until bearing drag is no longer evident and insert cotter key and spread.

O. Install hub grease cap and secure in place with capscrews and lockwashers.

SPRINGS—REMOVAL

1. Remove counter weight from the machine by using chain fall and place on floor after removal.

2. Remove cotter pin from rear spring hanger and drive out shackle pin, do the same at the front spring hanger, driving out shackle pin.

3. Remove jam nut and nut from spring U bolts and remove both U bolts from axle; this will allow spring to be removed.

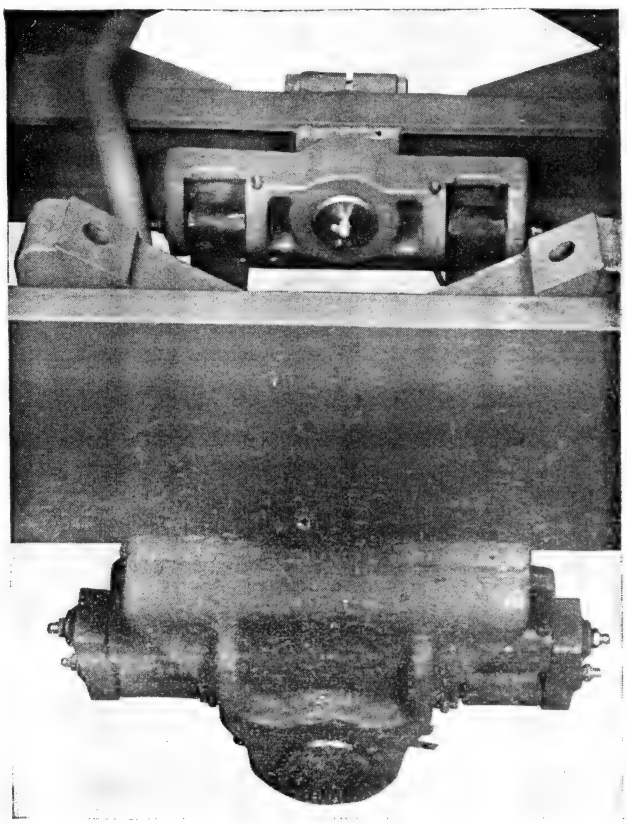


Fig. 40

4. It is advisable to change one spring at a time, so as it will not be necessary to remove or replace the steering axle.

5. In driving out the shackle pin, remove the grease fitting from the center pivot pin, so the shackle pin can be driven out with a drift pin. This applies to the front spring hangers.

SPRINGS INSTALLATION

1. Install spring shackles and shackle pins, to spring hangers.
2. Replace springs.
3. Replace U bolts to steering axle.
4. Replace grease fittings and cotter pins and shackle pins.
5. Replace counter weight, holding to frame replacing both halves of hood and connecting gasoline line to drain petcock on tank.

STEERING TROUBLE SHOOTING GUIDE

Trouble shooting for steering must necessarily include all parts of the steering mechanism. The foregoing section, for example, has dealt with the steering axle. The causes of steering difficulties may originate from or be confined to the steering gear although the results may appear to be in the axle.

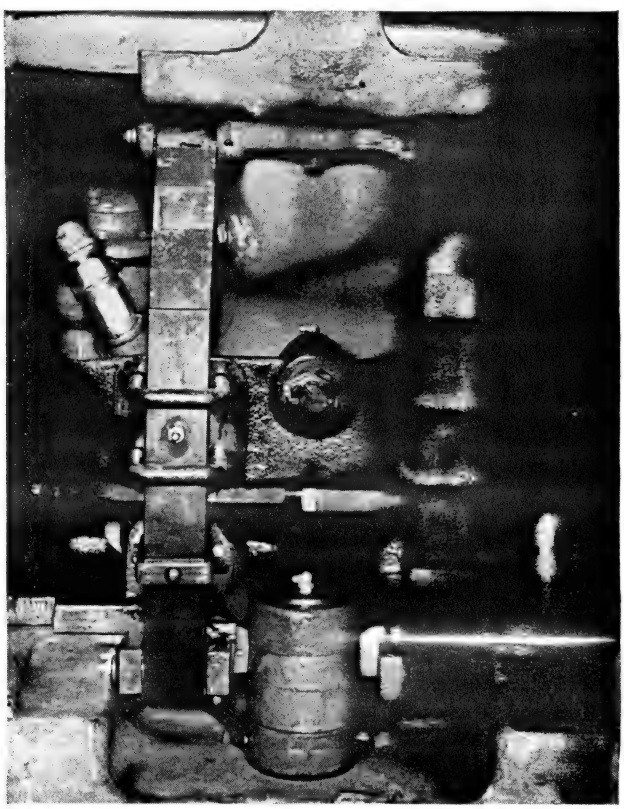


Fig. 41

HARD STEERING

1. Improper adjustment of steering gear worm bearing, section shaft lash, or drag link. Check adjustments in "Steering Gear" sections of manual.
2. Lack of lubrication. Lubricate as directed in steering gear section also lubricate all pressure gun fittings on axle, drag link and connecting parts.
3. Bent controls in steering gear linkage. Check as outlines in "adjustments" paragraph in this section.
4. Bent, broken or worn axle parts. Replace damaged parts.
5. Steering wheel misalignment. Adjust to 0" toe in on flat surface, machine empty and standing.

WANDER OR LACK OF STEERING CONTROL

1. Loose steering gear mounting, pitman arm loose or excessive sector gear backlash. Check and adjust as necessary.
2. Loose drag link ball socket. Tighten or replace worn parts.
3. Wheel and axle misalignment. Check and make necessary corrections.
4. Steering system parts worn. Overhaul and replace worn parts.

ROAD SHOCK TRANSMITTED TO STEERING WHEEL

1. Worn or mal-adjustment of wheel bearings. Replace or adjust as necessary.
2. Broken, bent or worn steering mechanism parts. Replace damaged parts.
3. Improper steering gear or drag link adjustment. Check and adjust. Refer to "Steering Gear" section.
4. Bent wheel or improperly mounted tire on wheel.
5. Improperly adjusted or worn bearings. Adjust or replace.

VEHICLE PULLS TO ONE SIDE

1. Incorrect wheel or axle alignment.
2. Broken, bent or worn axle and axle attaching parts. Replace damaged parts.
3. Unequal tire inflation. Correct to manufacturer's recommendation.
4. Worn or improperly adjusted wheel bearings. Adjust or replace.

HYDRAULIC BRAKE SYSTEM

DESCRIPTION AND OPERATION OF SYSTEM

The service brake system is of the hydraulic type activated by a foot pedal which pushes plunger forward in master cylinder. This in turn forces oil through lines to wheel cylinders. The wheel cylinders are mounted between the free ends of the two brake shoes which are opened outward to contact wheel brake drums when pedal is depressed.

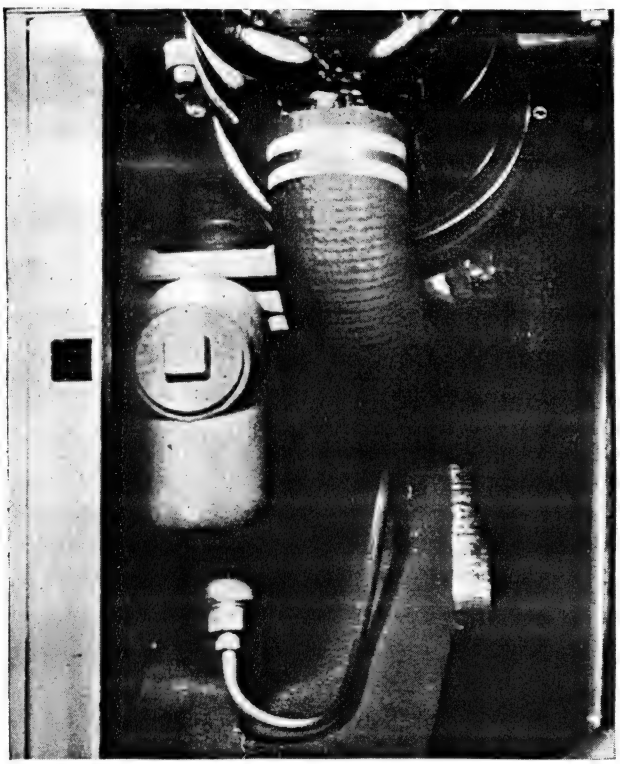


Fig. 42

BRAKE CYLINDERS

There are three brake cylinders in the service brake system. Two wheel cylinders are located one in each wheel. The master cylinder is located under air cleaner and is mounted to frame.

SERVICE BRAKE SHOES

DESCRIPTION. The service brake shoes are mounted so that when they are expanded they contact the drive wheel brake drums. These are faced with a molded brake lining. There are two brake shoe assemblies in each driving wheel. Each shoe is secured at one end by the brake shoe anchor pins. The other ends of the brake shoes are mounted to the ends of the wheel cylinder so that they move outward to contact the brake drum when oil pressure is applied to the cylinder.

ADJUSTMENT:

1. Minor Adjustment: The brake shoe adjustments are divided into two classes—minor and major.

2. A minor brake shoe adjustment is made by moving the toes of the brake shoes outward by means of the adjusting cam.

3. The adjusting cam may be reached from the outside of the brake support plate.

4. To adjust, tilt upright in toward driver and place block under edge of uprights.

5. Now tilt upright forward, raising wheels a few inches from floor.

6. With wrench turn cam adjusting nut out on the front shoe until lining is solid against the drum and the wheel cannot be moved.

7. Then turn cam nut in enough to allow wheel to be spun freely.

8. The shoes are now in a closer position to the brake drum and will contact the drum with a shorter pedal depression.

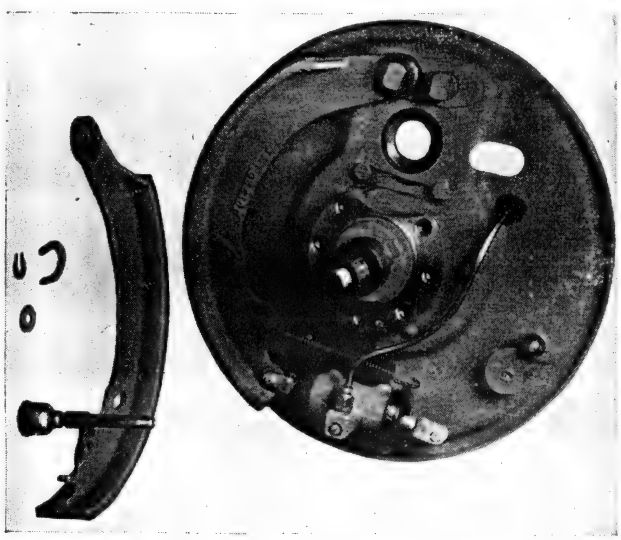


Fig. 43

9. Repeat this operation to the back shoe and the front and back shoes of other drive wheel.

1. Major Adjustment: A major brake shoe adjustment involves moving both the toes and heels of the brake shoes to centralize the shoes in relation to the brake drum braking surface.

2. To remove drive wheels, tilt the upright back toward the driver as far as it will go, place a two-inch by four-inch block under the bottom of the upright channel and tilt the upright forward until the drive wheels just clear the floor.

3. Back-off brake adjustment to full release position.

4. Remove hub cap capscrews and remove hub cap.

5. Remove cotter from wheel bearing adjusting nut, then with proper wrench, remove adjusting nut.

6. Remove thrust washer and outer bearing cone, then remove wheel from assembly.

7. Pull inner bearing cone and grease retaining washer from axle shaft.

8. Cut and remove lockwire from wheel disc screws; then with proper wrench, remove the screws.

9. Complete disc, drive pinion and drive shaft assembly may now be removed from axle.

10. Remove the brake shoe return springs and test of tension.

11. Inspect shoes lining for exposed rivet heads and glazed braking surface.

12. Inspect brake drums for grease and look for scoring or rough spots and loose bearing cups.

13. Install brake shoe return springs and set cams in released position.

14. Install dust plates and wheels and brake drums.

15. Using a master ring with same I.D. as drum, set heel of shoes .010 from drum at anchor points.

16. Lock anchor pin nuts securely.

17. Adjust toes of shoes shown under minor adjustment. Cam adjusting screws are self locking.

INSTALLATION

1. Install wheel disc and shaft assembly and secure in place with cap screws.

2. Install lockwire in screws to prevent loosening. Install shaft also bearing grease tube.

3. Install grease retaining washer, on axle shaft, then inner wheel bearing cone.

4. Install wheel assembly on axle shaft and entering gear teeth simultaneously.

5. Install in order, the outer bearing cone, thrust washer, and adjusting nut.

6. With proper wrench, tighten nut solidly while rotating the wheel, to insure proper seating of bearings. Back off adjusting nut approximately one-sixth of a turn and install cotter key and spread.

7. Install hub grease cap and secure in place with cap screws and lockwashers.

BLEEDING THE BRAKES

1. This operation is necessary to eliminate air from the system causing a springy or spongy foot pedal action.

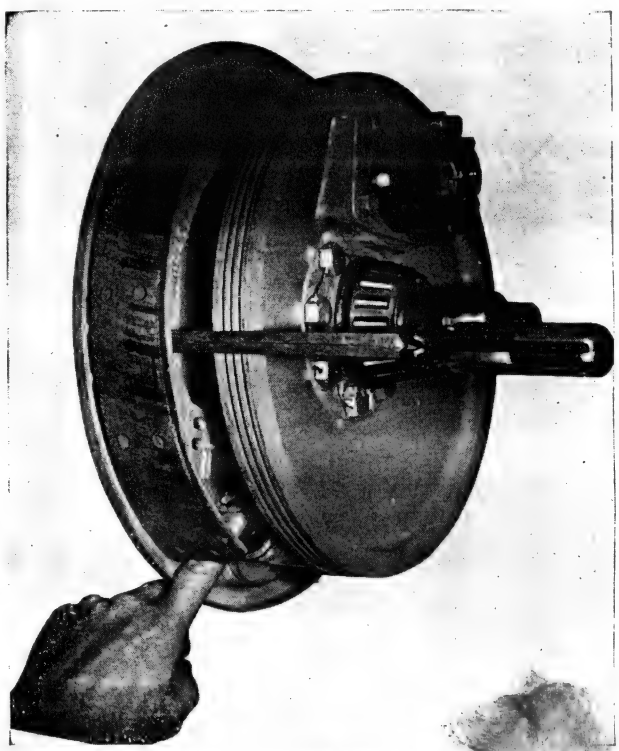


Fig. 44

2. Block up the front end of vehicle a few inches from the floor and remove driving wheels.

3. Using two heavy screw drivers for prys insert one between the brake band and outer flange and using one as a pry, lift the brake band up as far as possible.

4. Insert the other one in such a position as to hold the brake band in the up position.

5. Remove connecting link and boot from upper end of wheel cylinder. Hold thumb over end opening in wheel cylinder and with the other hand pump foot pedal gently until pressure forces piston out.

6. The longest line runs to the brake which is to your left as you face the upright and this line should be bled first otherwise air will remain in the line and "soft brakes" will continue.

7. Using a self-regulating jar, fill the master cylinder with fluid, press thumb firmly over rubber cup which was forced up behind piston when piston was pumped out.

8. With other hand pump the brake pedal gently, making sure there is a constant flow of fluid from the master cylinder.

9. Air bubbles and some fluid will be forced out around your thumb. Allow foot pedal to return (after being depressed) very slowly as air may be drawn into the system if allowed to return too quickly.

10. Continue to pump until air bubbles no longer appear in fluid forced out around thumb. Push the rubber cap back into cylinder and install piston, boot and connecting link.

11. Remove screw drivers allowing brake shoe to return to its normal position. Install wheel and repeat operation to other wheel cylinder.

BRAKE PEDAL ADJUSTMENT

1. After a minor or major brake adjustment the travel of the brake foot pedal should be checked.

2. The total travel of the brake foot pedal is composed of the following three steps; (a) The travel of the piston rod before touching the piston in the master cylinder; (b) The distance the piston travels to cover the relief port; (c) The travel of the brake shoes to contact the drums. Pedal travel (a) is termed "free play" and should be one-eighth inch to one-fourth inch.

3. This free play of pedal can be felt readily by depressing the pedal by hand until the push rod touches the master cylinder piston. If necessary, adjust length of the master cylinder push rod.

4. Pedal travel (b) can best be determined by looking into the master cylinder reservoir through the filler cap opening while depressing the pedal slowly.

5. After the initial free play (a) has been taken up, brake fluid should be forced up through the relief port until the pedal has traveled through an additional five-eighths inch to three-fourths inch making a total travel in order to close the relief port with the primary cup of three-fourths inch to one inch.

6. If fluid does not come up through the relief port until the pedal has traveled through of much less than three-fourths inch the free play should be checked.

7. If the free play is not the cause, the master cylinder should be disassembled and inspected for swollen cups, etc,

8. An additional travel (c) of one inch required to move the shoes outward against the drums.

9. The total pedal travel to set the brakes tightly against the drums should be approximately one and three-fourths inch to two inches with properly adjusted brakes.

10. Brake shoe cam adjustment will usually rectify excessive pedal travel.

MASTER CYLINDER
REMOVAL

Disconnect master cylinder to tee line at cylinder, and brake pedal rod cylinder. Remove screws, lockwashers and nuts attaching cylinder to bracket and remove cylinder.

DISASSEMBLY

Remove the following parts in the order listed:

Large boot strap
Piston rod
Reservoir filler plug and lock rings

Pull out piston stop washer and piston then tip open end of cylinder downward and piston return spring and inlet valve assembly will fall out.

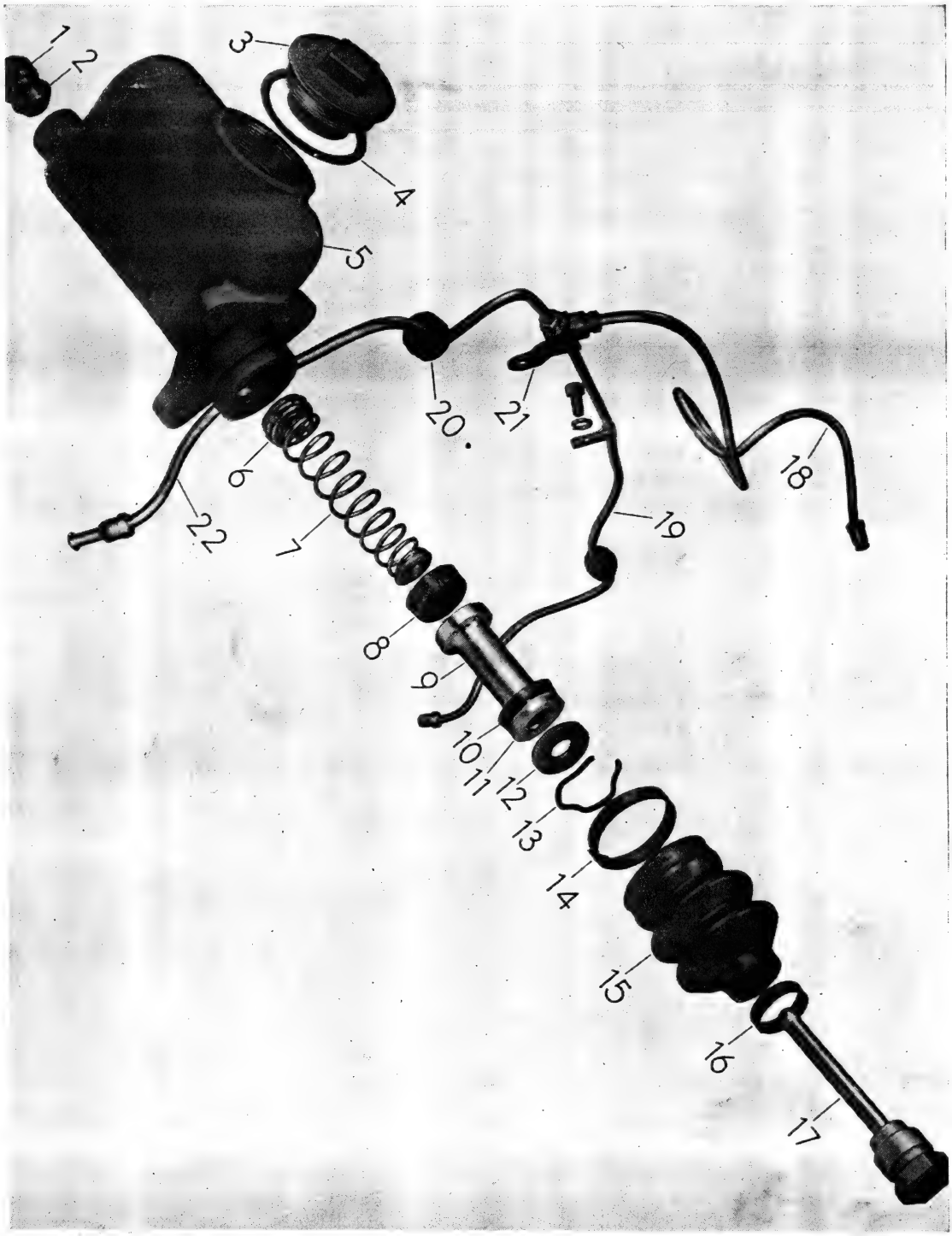


Fig. 45

CLEANING, INSPECTION AND REPAIR

Clean all parts thoroughly, and wash parts with alcohol before assembly. Make sure no scores or scratches appear on cylinder wall. Replace all worn or defective parts. Coat walls of cylinder and internal parts with brake fluid before assembly; never use mineral lubricant for this purpose.

INSTALLATION

Install master cylinder to bracket and install

screws, nuts and lockwashers, connect brake pedal rod at cylinder and connect cylinder to tee line at cylinder.

PARKING BRAKE DESCRIPTION

The parking brake on this machine employs a Mico brake lock. The brake lock is a hydraulic valve that converts the service brakes into a positive holding brake by locking the brake fluid in the brake lines. It is electrically actuated, but it holds and releases hydraulically without any current draw.

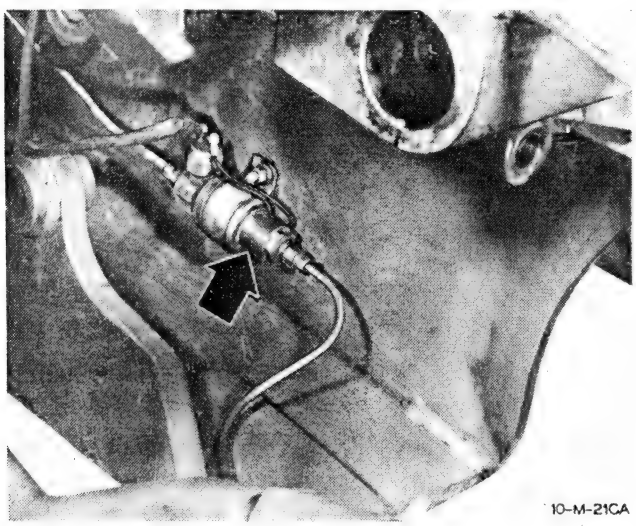


Fig. 46

Operation of the Mico brake lock is controlled by a pressure operated switch and a manually operated dash switch connected in series. When the driver desires to lock the brakes of his vehicle, he holds the dash control switch "on" and steps on the foot brake. THE DASH SWITCH MUST BE HELD ON UNTIL BRAKE PEDAL IS RELEASED. The pressure switch automatically energizes the solenoid as the driver steps on the brake pedal.

The solenoid is used to operate a poppet valve inside the brake lock. This valve is normally held open by a spring and closes only when the energized solenoid overcomes spring tension.

As the driver releases his foot brake with the dash switch held "on," pressure in the wheel cylinders, working on the head of the poppet valve, holds the poppet valve in its seat. Thus, the poppet valve is sealed by a positive hydraulic force independent of any electrical condition. There is no pressure from the head of the poppet valve back through the system to the master cylinder. Since the pressure switch is located on the inlet (master cylinder side) of the brake lock, there is no pressure on this switch and it opens, preventing further current draw from the battery. To release the brake lock the driver must step on the brake pedal equally as hard as he did to lock the unit. This balances the hydraulic pressures across the poppet valve and allows the poppet valve spring to force the poppet valve open.

MAINTENANCE

If brake lock valve will not close:

1. Check electrical circuit to determine that current is supplied to pressure switch on brake lock while dash control switch is at "on" position.

2. Check pressure switch on brake lock with test lamp while the dash control switch is at "on" position. The circuit should make and break with the application and release of the brake pedal. If the pressure switch is defective, it can be replaced with any heavy duty stoplight switch having suitable terminals.

3. If the brake lock solenoid coil should become shorted, it will be necessary to exchange entire unit.

REMOVAL AND INSTALLATION

The brake lock unit is mounted to the frame below the left hand tilt cylinder. To remove, disconnect brake line at each end of brake lock, disconnect wire at pressure switch, remove bolt holding unit to frame, and remove unit.

To replace, reverse procedure given above.

HYDRAULIC BRAKE SYSTEM TROUBLE SHOOTING GUIDE

Pedal goes to floorboard

CAUSES

1. Normal causes of wear of lining.
2. Brake shoes not properly adjusted.
3. Leak in system.
4. Air in system.
5. Pedal improperly set
6. No fluid in supply tank.

Both brakes drag

CAUSES

1. Mineral oil in system.
2. Pedal improperly set.

One wheel drags

CAUSES

1. Weak or broken brake shoe return spring.
2. Clogged or crimped hydraulic brake line.
3. Brake shoe set too close to drum.
4. Piston cups distorted.
5. Loose wheel bearings

Machine pulls to one side

CAUSES

1. Grease soaked or fluid soaked linings.
2. Shoes improperly set.
3. Backing plate loose on axle.
4. Different makes of linings.
5. Clogged or crimped brake line.

Springy, spongy, pedal

CAUSES

1. Brake shoes not properly adjusted.
2. Shoe surface not square with drum.
3. Air in system.

Excessive pressure on pedal, poor stop

CAUSES

1. Brake shoes not properly adjusted.
2. Improper lining.
3. Oil or fluid on lining.
4. Lining making partial contact.

Overly sensitive brakes

CAUSES

1. Brake shoes not properly adjusted.
2. Loose brake bushing plates.
3. Grease soaked or fluid soaked linings.

COOLING SYSTEM

DESCRIPTION. The cooling system of the engine consists of a radiator, water pump, thermostat, fan, belt and connections. The fan is driven by a "V" belt from the crankshaft pulley. The fan is of the double pulley type, the extra pulley furnishing power for generator.

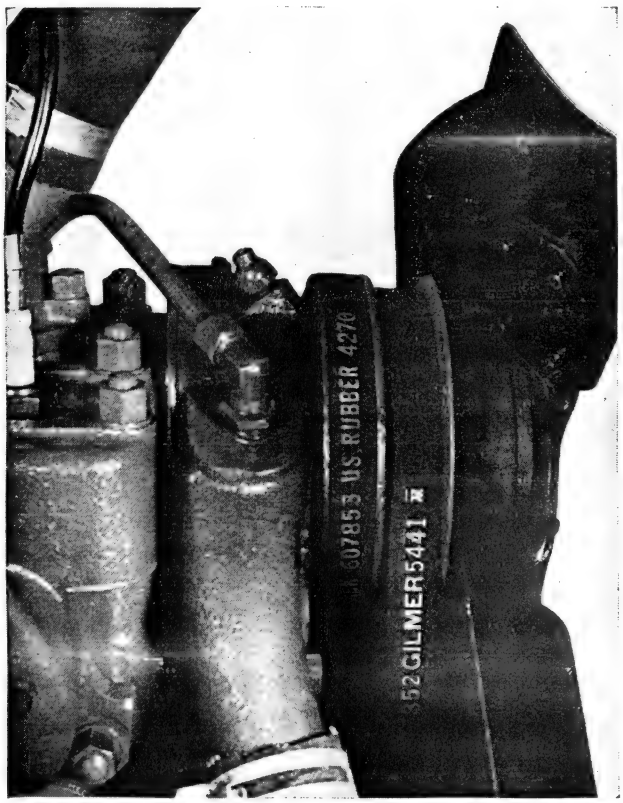


Fig. 47

DATA

Fan:

Number of Blades	4
Diameter of Fan	15 in.
Adjustment	Belt

Belt:

Type	"V"
Dim.	43" O.C. x 4⅛" L.C.

Radiator:

Capacity (complete cooling system)	17 qts.
Location of filler cap	Top, rear, of hood.

COOLING SYSTEM MAINTENANCE

Filling Cooling System. Remove radiator cap from filler pipe located on top of hood. Fill cooling system. Run motor to expel any air pockets at pump and thermostat and recheck.

Inspection of Cooling System Units. Inspect all hose connections and hose connection clamps. Clamps must be tight and hose connections must not leak. Inspect drain cock on radiator and cylinder block for leakage. Examine all gaskets at water connections for leaks and tighten all bolts and nuts at these water connections.

Anti-freeze Chart. Ethylene glycol is the only anti-freeze compound prescribed for use in this vehicle. Pour solution into radiator until radiator is filled. Start engine and run until normal temperature is reached. Refill radiator to proper level.

Ethylene Glycol (Quart)	Water (Quart)	Protects to Degrees F.	Gravity
0	20	32	1.000
2	18	26	1.016
4	16	16	1.031
6	14	— 3	1.045
8	12	—11	1.058
10	10	—31	1.070

COOLING SYSTEM MAINTENANCE

Cooling system overheats. Lack of cooling solution, refill system.

Clogged system. Flush and clean system.

Hose leaking. Tighten hose clamps or replace faulty hose.

Water pump thermostat not operating or clogged, replace with new thermostat.

Frozen radiator. When the motor overheats very quickly, it indicates a complete clogging of the cooling system, either from ice, slush or some foreign obstruction. If evidence of freezing is found, cover the radiator with a heavy blanket or tarpaulin and run the engine slowly, shutting it off each time the motor temperature causes liquid to

steam. Repeat this operation until cooling liquid thaws. If the obstruction is not snow or ice, reverse flush the cooling system.

Loose or open drain cocks and plugs. Inspect and tighten.

Damaged radiator core. Seal or replace radiator.

Check radiator core, hose, cap and gaskets for good condition and inspect for leaks. Examine air passages and guards for obstructions and clean out dirt, insects, leaves or trash. Test and record antifreeze reading as the climate demands. Check water for presence of oil, rust or foreign matter. Clean and flush the radiator as needed.

Inspect hose clamps for leaks.

Check fan and generator belts for slack and tighten same.

REVERSE FLUSHING COOLING SYSTEM—RADIATOR

Remove upper and lower radiator hose, and replace radiator cap. Attach a length of hose to the radiator top connection, then attach a length of hose to the radiator lower connections and insert reverse flushing gun in this lower hose. Connect the water hose of the gun to a water tap and the air hose to a compressed air line. Turn on the water and when the radiator is full, turn on the air in short blasts. Allow radiator to fill with water between blasts of air. Continue this flushing until water from top hose runs clear.

REVERSE FLUSHING COOLING SYSTEM—MOTOR BLOCK

Remove hose from water inlet elbow and attach a length of hose to the inlet, then remove hose from water outlet elbow and attach a length of hose to the outlet, then insert gun in this hose. Repeat procedure as above described for radiator.

WATER PUMP—REMOVAL AND INSTALLATION

1. Follow procedure for removing radiator.

2. Remove two capscrews from water pump housing to block, (NOTE: These are not the same length) the long capscrew goes through the pump housing just below the water inlet and the short capscrew goes in through the short boss in the pump housing.

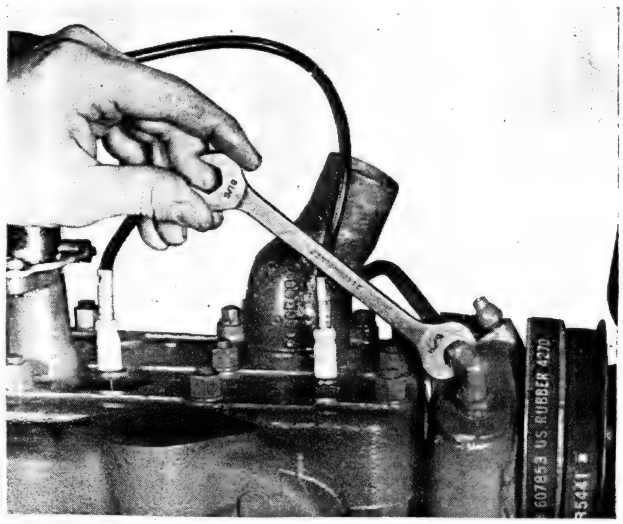


Fig. 48

3. Loosen the other two capscrews and back out as far as possible, (NOTE: They will not come out as the heads of the capscrews strike the pulley flange).

4. Remove water pump by pass line at water pump to motor block.

5. Loosen old gasket and remove water pump assembly with fan blades from the motor.

To replace water pump assembly, reverse the above operation. Caution—use new gasket.

THERMOSTAT—REMOVAL AND INSTALLATION

To remove thermostat:

1. Drain water at radiator drain cock.

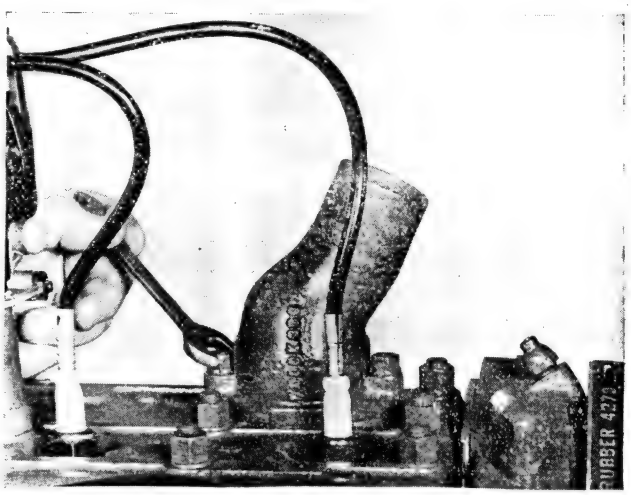


Fig. 49

2. Remove water recirculating tube at water pump and cylinder head water outlet.

3. Remove two nuts at outlet elbow.

4. Remove outlet elbow and gasket.

5. Remove thermostat and expansion ring, by pushing thermostat out from top of elbow.

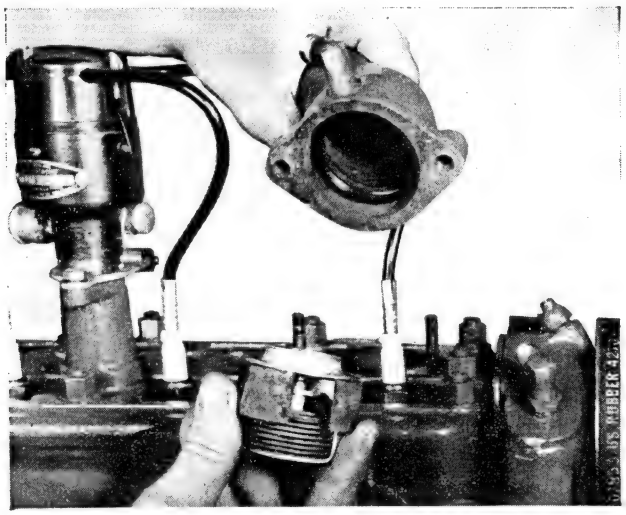


Fig. 50

To install thermostat, reverse above procedure.

1. Replace gasket

2. Caution: Do not let the expansion ring cover by-pass opening in elbow.

RADIATOR REMOVAL

1. Shut off gas tank petcock at gas tank.

2. Disconnect gas line at petcock.

3. Disconnect gas gauge wire.

4. Remove both hood halves.

5. Drain radiator and cooling system at radiator drain petcock located at left lower corner of radiator, and drain block at side of engine.

6. Remove exhaust pipe brass nuts at manifold.

7. Remove tail pipe clamp at counterweight.

8. Remove governor spring tension bracket bolts.

9. Remove bolts from muffler support at timing gear cover.

10. Remove muffler assembly.

11. Remove top and bottom radiator hoses.

12. Loosen four counterweight bolts and permit counterweight to gap back from frame 1".

13. Remove four capscrews from radiator support to frame.

14. Remove four rubber washers between radiator supports and frame.

15. Remove radiator from the machine.

RADIATOR INSTALLATION

1. Place radiator in the machine.

2. Install four rubber washers between radiator supports and frame.

3. Install four capscrews to radiator support to frame.

4. Tighten four counterweight bolts.

5. Install top and bottom radiator hoses.

FAN BELTS

Description.

Fan belts used in this vehicle are of the "V" type. Two different applications are used:

Vehicles have one fan belt and one generator belt. The generator is driven by a short belt connected from generator pulley to fan pulley.

Adjustment

Vehicles using two belts (generator and fan belts) adjustment is made by loosening two set screws holding outer flange on fan hub and with punch drive flange clockwise to tighten fan belt and counterclockwise to loosen. Fan belt is to be adjusted so that there will be a one-inch deflection at longest side of belt. To adjust generator belt loosen generator hinge and strap. Move generator outward to tighten belt. The correct adjustment on the generator belt is one-half inch deflection measured on long side.

COOLING SYSTEM TROUBLE SHOOTING GUIDE

EXCESSIVE ENGINE TEMPERATURES

CAUSES

1. Ignition timing too late or too early.

2. Engine fan belt slipping.

3. Abnormal water loss from cooling system.

4. Radiator tubes restricted or clogged.

5. Radiator core surface restricted.

6. Radiator core covered with heavy paint or dirt accumulation.

7. Engine thermostat not opening properly.

8. Engine thermostat reversed when installed.

9. Deteriorated or collapsed water pump inlet hose.

10. Pump impeller loose on shaft.

11. Abnormal clearance of impeller in pump housing.

12. Abnormal sludge or dirt accumulation in radiator or water jacket of engine block.

13. Any condition that will result in preignition.

14. Restriction of water transfer holes in engine block or cylinder head.

15. Cylinder head gasket improperly installed.

16. Foreign object, such as wooden plug in cylinder head, which floats and occasionally obstructs water circulation.

17. High frictional resistance in engine assembly resulting from:

a. Insufficient internal clearance.

b. Internal misalignment.

c. Use of heavy engine oil.

d. Insufficient oil circulation.

18. Dragging brakes.

19. Tight wheel bearings.

20. Abnormal frictional resistance in power transmitting units.

21. Use of certain types of anti-freeze solutions in warm weather.

22. Clutch slipping.

WATER LOSS FROM COOLING SYSTEM

CAUSES

1. Radiator leaks.

2. Radiator or water pump hose leakage.

3. Cooling system drain plug or valve leakage.

4. Water pump leakage.

5. Cooling system gasket leakage.

6. Cylinder block or cylinder head cracked (leaking externally or internally).

7. Loose radiator upper tank baffle plate.

8. Combustion gases leaking into cooling system because of poor seal of cylinder head gasket due to faulty gasket or loose cylinder head nuts.

9. Engine thermostat not functioning properly or operating without a thermostat.

10. Engine overheating resulting in water boiling and loss through overflow pipe.

WATER PUMP NOISES
DESCRIPTION

Water pump noises are rare and are often difficult to locate. A noisy water pump, however, can generally be detected by the use of a sounding rod against the water pump body. Water pump noises are usually indicated by a scraping sound, squeal, or bump.

CAUSES

1. Pulley loose on pump shaft.

2. Pump impeller loose on pump shaft.

3. Excessive end play of pump shaft.

4. Impeller blades rubbing water pump housing.

5. Impeller broken or pin sheared.

FAN NOISES DESCRIPTION

Fan noises due to the condition of the fan belt are usually apparent by a squeal in the forward part of the engine when the engine is idling or when the engine is rapidly accelerated.

Fan noises have various characteristics but can generally be located when the engine is idling. Paragraphs a, b, and d under Cause No. 2 will cause an intermittent thud. Paragraph c under Cause No. 2 will cause a light metallic rattle at low speed with an uneven engine idle. The fan blades striking the radiator or fan belt will cause a decided scraping sound. Paragraphs f, g and h under Cause No. 2 will generally cause a whir or hum at the higher engine speeds.

CAUSES

1. Fan belt noises.

a. Belt adjusted too tight (squeal).

b. Belt adjusted too loose (squeak on acceleration).
c. Grease, rust, or foreign matter on fan belt or pulleys.
d. Incorrect type or make of fan belt.
e. Fan belt badly worn or burned.
f. Misalignment of fan belt pulleys.

2. Fan Noises
a. Excessive water pump shaft end play.
b. Fan blades loose on hub.
c. Crankshaft, generator, or fan pulleys cracked or distorted.
d. Fan hub loose and turning on shaft.
e. Fan blades striking fan belt or radiator.
f. Unbalanced fan blade assembly.
g. Uneven pitch of fan blades.
h. Bent or distorted fan blades.

PREMATURE FAN BELT BREAKAGE OR RAPID WEAR

CAUSES

1. Tight adjustment causing abnormal stretch.
2. Loose adjustment causing excessive slippage.
3. Use of incorrect type belt.
4. Oil on belt causing deterioration.
5. Misalignment of belt pulleys.
6. Belt striking or rubbing on fan blades.
7. Excessive friction in water pump or generator causing overload on belt.
8. Sustained high speeds.
9. Broken or rough fan pulley flanges.

NOTES

DYNATORK DRIVE MECHANISM

CONSTRUCTION AND OPERATION

The dynatork drive mechanism is an electromagnetic device used in place of a clutch to couple the flywheel rotation to the transmission assembly.

The dynatork drive mechanism consists of a thermal type circuit breaker, caterpillar or control resistor, directional master switch, a forward and a reverse coil, two positive brushes for each coil, a single ground brush, and a two ohm shunt resistor for the positive brushes.

CIRCUIT BREAKER

The circuit breaker is electrically located between the power source and the caterpillar resistor. It is physically located on the left rear of the seat plate. Its purpose is to limit the amount

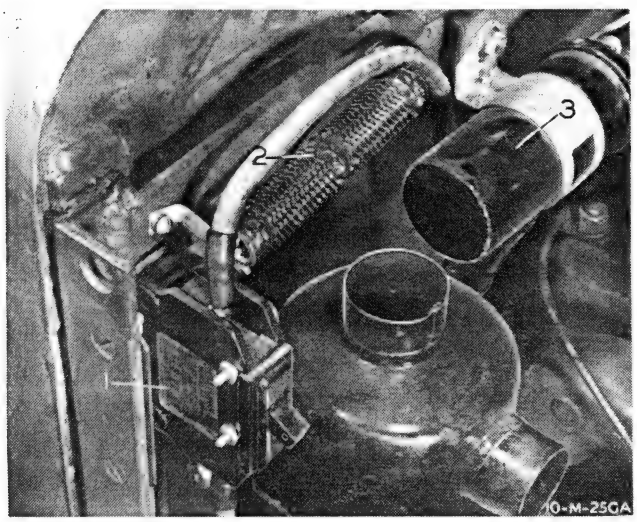


Fig. 51

of current going into the dynatork drive unit. If, for some reason, excessive amperage is going to the dynatork coil, the circuit breaker will heat up and open, breaking the electrical connection from the power source to the coils. This circuit breaker can be reset by pushing the reset lever.

CATERPILLAR RESISTOR—DESCRIPTION

The caterpillar resistor consists of a series of carbon discs mounted under tension by an insulated bolt.

A series of finger contacts which can be mechanically opened or closed are provided to shunt or by-pass each carbon disc. In other words the caterpillar resistor is a carbon pile variable resistor. It is electrically located between the circuit breaker and the directional master switch. Its

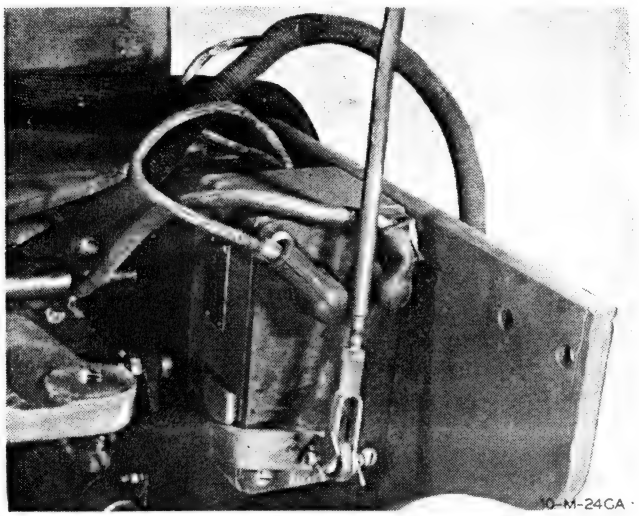


Fig. 52

physical location is under the floorboards, connected by linkage to a foot pedal. The purpose of the caterpillar resistor is to control the amount of voltage used across the dynatork coils and consequently the strength of the magnetic field built up by the coil.

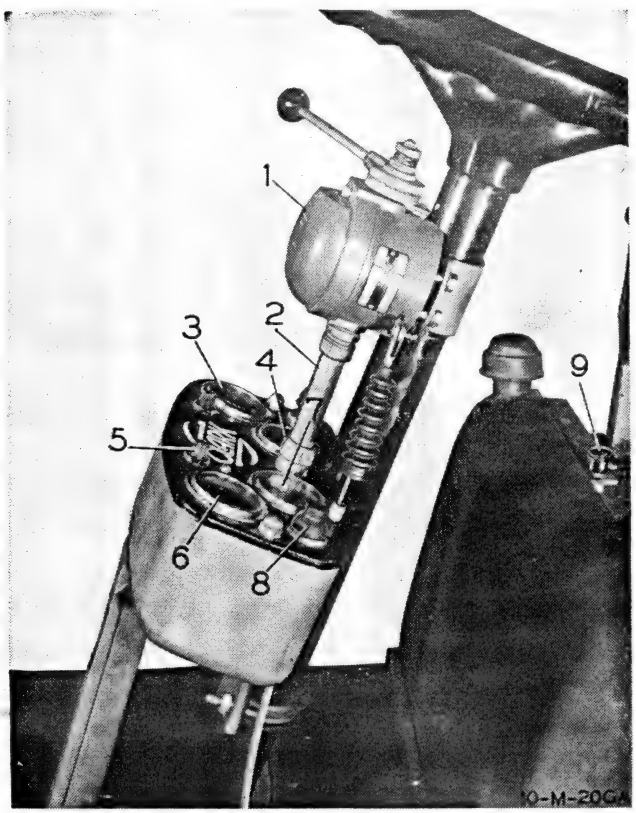


Fig. 53

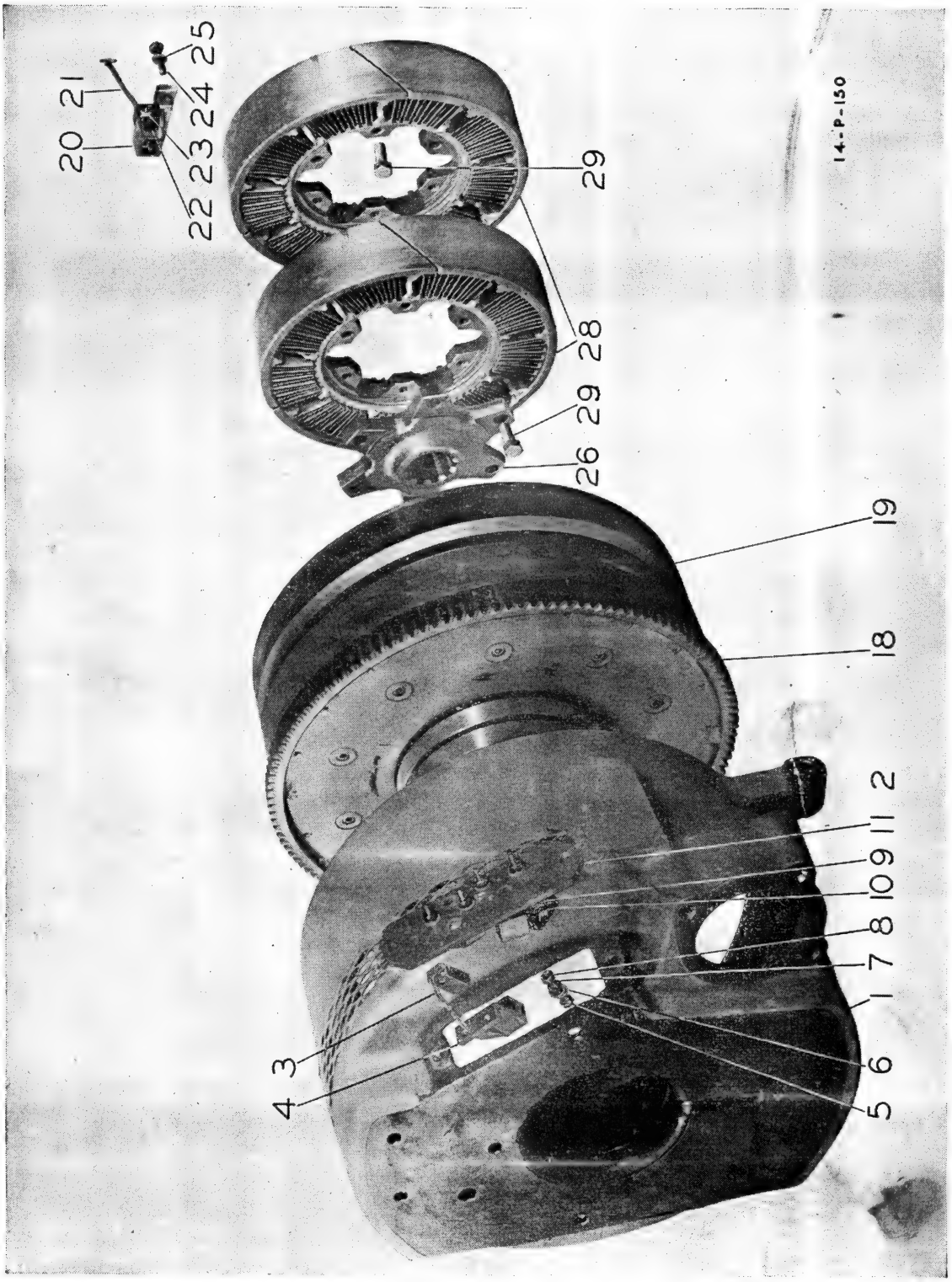


Fig. 54

DIRECTIONAL MASTER SWITCH

The directional master switch is physically located on the steering column. The lever has three positions, neutral or off, forward and reverse. It is electrically connected so that when the lever is "OFF" the circuit to the dynatork coils is open so that no current is transmitted to either dynatork coil. When the lever is placed in the forward position the forward coil is energized, and with the lever in reverse, the reverse coil is energized. Therefore, the directional master switch controls the direction in which the machine will move.

FLYWHEEL AND DYNATORK COILS

There are two dynatork coils wound around individual pole shoes and mounted rigidly to the flywheel. One coil is for the forward direction and one coil for the reverse direction. Each coil provided with a slip ring and dual brush connection to the proper side of the directional master switch. Both coils are grounded to the flywheel. There is a ground brush riding on the flywheel end cover to give a positive ground return. There is a 2 ohm resistor connecting the positive brushes to ground. The purpose of this resistor is to cut down the arcing between the brushes and slip rings.

Power requirements for the dynatork unit is six volts at twenty-eight to thirty-four amperes and is furnished by a six volt fifty ampere generator.

FLYWHEEL AND DYNATORK COILS REMOVAL

The flywheel, dynatork coils, pole pieces, and slip rings must be serviced as a complete assembly.

Access to the flywheel can be obtained by removing the transmission and rotor assembly. Refer to section on transmission for procedure to remove the transmission.

Remove the six nuts that hold the flywheel assembly to the crankshaft.

Take out the cap screws that hold the right and left brush blocks to the flywheel housing. Carefully lift the brush blocks up to free the brushes from contact with the slip rings.

Use two cap screws through the two jack screw holes to jack the flywheel assembly off the crankshaft flange.

NOTE: The flywheel cannot be replaced incorrectly as one of the mounting studs is off center one-eighth inch and the flywheel will fit in only one position.

MAINTENANCE AND INSPECTION

Maintenance of the flywheel assembly can always be accomplished without removing the flywheel assembly. Only if it is necessary to replace the flywheel assembly will removal be required.

Inspect the slip rings on the flywheel for burrs, pits, or burns. Clean the slip rings with a solution of carbon tetrachloride. Dry thoroughly with a clean cloth. Inspection can be accomplished through the openings where the brush blocks are mounted.

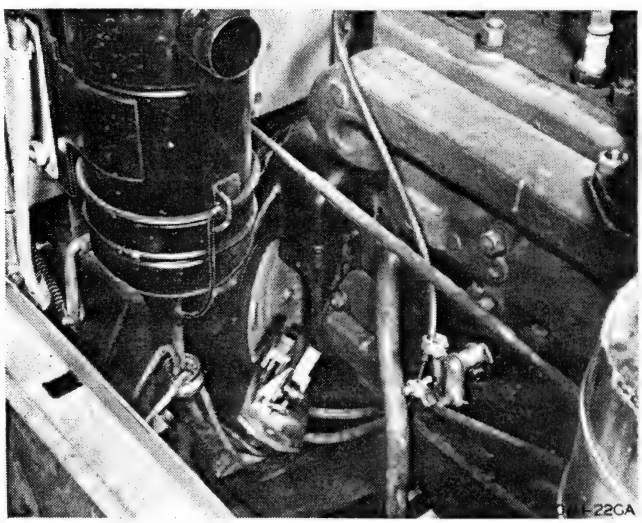


Fig. 55

Inspect the brushes in the brush block of the right and left brush blocks. There is a forward and reverse brush on each block. The forward brushes are connected by a jumper lead as are the reverse brushes. Wipe the brushes, holders, and blocks off with a clean dry cloth. NEVER use any cleaning solution on the brushes. Also remove and inspect the ground brush on the transmission. The brushes should make eighty per cent contact with their respective slip rings.

FLYWHEEL INSTALLATION

It is advisable to use a pair of calipers to locate the stud on the crankshaft flange that is off center

and its matching hole in the flywheel. Lift the flywheel into place in the flywheel housing and maneuver into position on the crankshaft flange. Thread on the retaining nuts with a lock washer under the nuts. Torque the nuts up to eighty pounds of torque wrench pull.

Carefully set the brush blocks into place on the mounting boss of the flywheel housing. Be sure the brushes seat up in the brush holders and are not binding. Install the cap screws that hold the brush blocks to the flywheel housing.

Install the transmission. Refer to the section on Transmission for proper procedure.

CATERPILLAR RESISTOR:

REMOVAL AND DISASSEMBLY

(Refer to Fig. 56)

Remove the cotter key and pull the pedal link out of the slot in caterpillar resistor actuating arm.

Take the rubber dust covers off the terminal studs. Remove the terminal nuts and lift off the electrical wires from the terminals.

Remove the two cap screws that hold the resistor unit to the frame mount. Lift resistor unit out of the frame.

Remove the four cap screws that hold the base and cover together and lift off the cover and actuating arm assembly.

Remove the three nuts on the terminal end of the resistor holding resistor assembly to base studs. Maneuver resistor and contact finger assembly off the base.

INSPECTION

Inspect the contact fingers for burning or pitting of the contacts, warped or deformed fingers, or any contact point that is not making contact with the contacts on each side.

Inspect the actuating arm assembly looking for excessive free play. If excessive free play is found it will be necessary to put new bushing in the cover.

Examine the actuating cam and return spring. Look for bad or weak spring or loose cam.

Replace any unit that is found to be defective.

CATERPILLAR RESISTOR REASSEMBLY

Maneuver the resistor and contact finger assembly into place on the base, fitting the terminal studs into the mounting holes. Turn on the retaining nut and pull up tight.

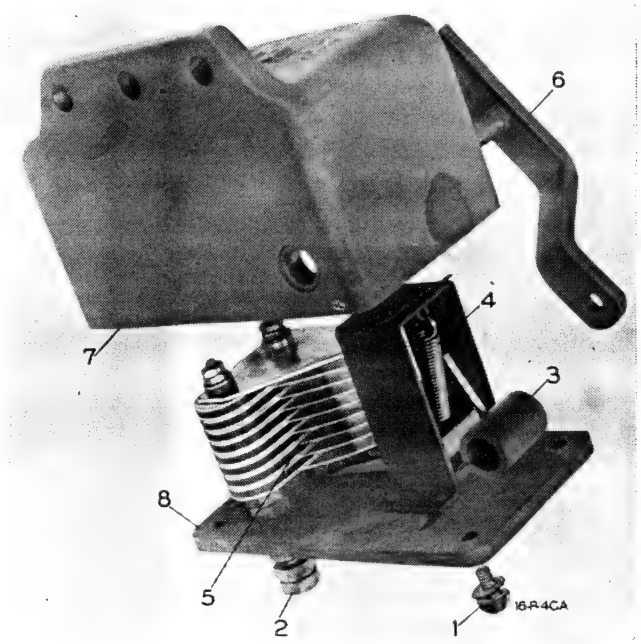


Fig. 56

Fit the base assembly into the cover carefully positioning the actuating lever on the contact finger cam. Turn in the cap screws that hold the cover to the base.

Set the caterpillar resistor assembly on the frame mount and secure with the two cap screws.

Put on one terminal nut on each of the two terminal studs. Fit the electrical lead terminals on the terminal studs and secure with retaining nuts. Pull the rubber dust covers over the terminals.

FORWARD AND REVERSE LEVER

(Refer to Fig. 57)

(Directional Master Switch)

The forward-reverse lever assembly is equipped with a positive "deadman" lock. When the driver leaves the seat, a strong tension spring raises the seat and pulls a cable that is connected to the lever lock on the directional master switch. As the lock actuating arm is pulled down by the cable, a spring loaded cam arrangement in the switch will automatically be tripped returning the lever to neutral and opening the contact points in the switch. A lock rod is pushed into place in the lock slot of the control lever, preventing the lever from accident-

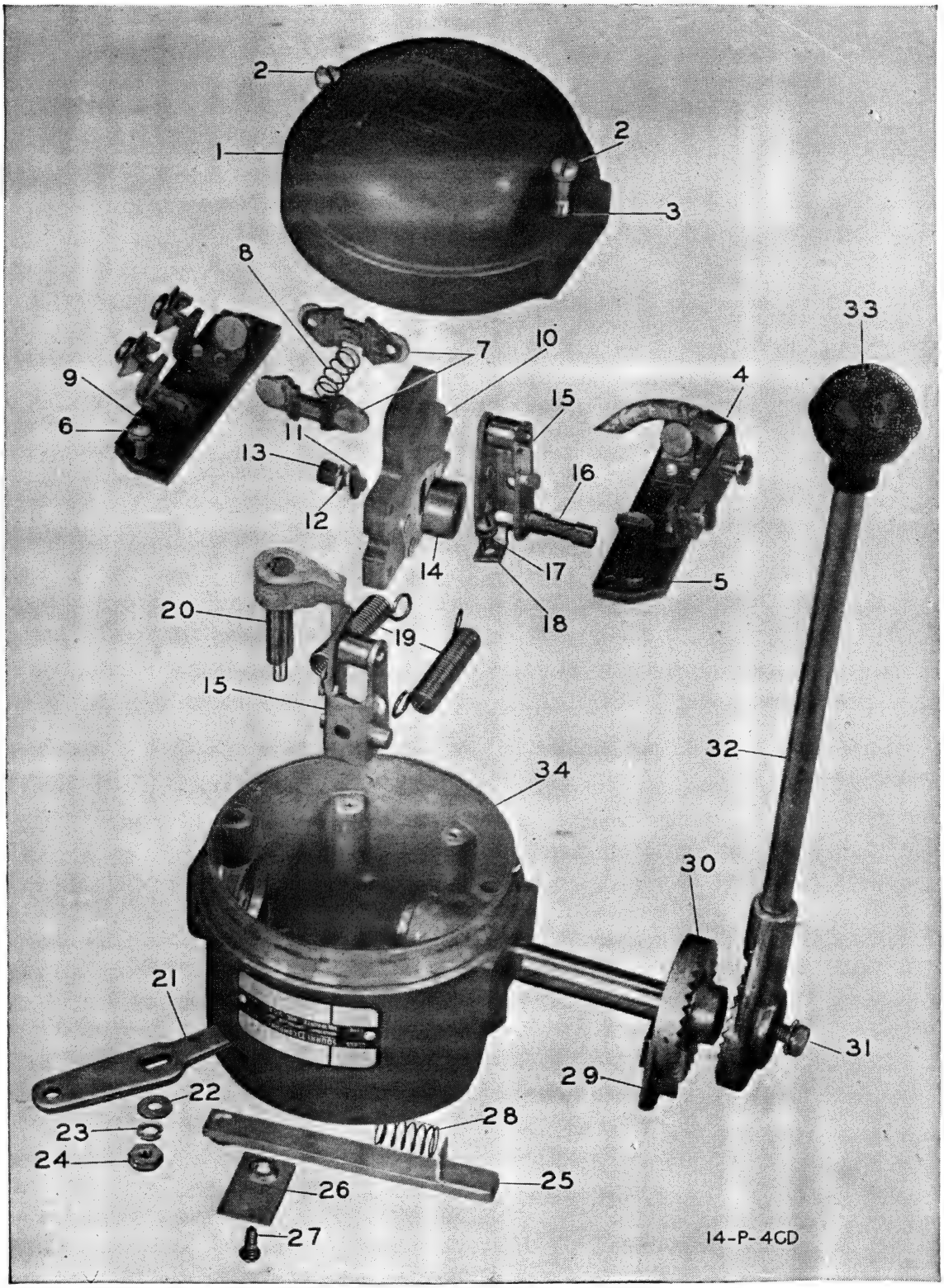

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Fig. 57

ally being moved to either the forward or reverse position.

The cable adjustment is secured by lifting the seat up to gain access to the tension spring adjustment. Loosen the lock nut on the cable end and turn the spring retaining nut until sufficient tension is obtained to raise the seat when empty and pull the cable in order to actuate the lock. This is the only adjustment on the lock cable mechanism.

Remove the cap screws that hold the cover plate on the directional master switch and remove the cover plate. This will allow a visual inspection of the inside of the switch assembly. Inspect the contact points and clean with a cloth moistened in a small amount of solvent. Do not use a file on these contacts. If the points are pitted badly or worn enough to warrant replacement, remove the points, both fixed and moveable, and install new contact points.

CIRCUIT BREAKER ASSEMBLY

The dynatork circuit breaker is located on the left rear side of the seat plate.

If, for some reason, the circuit is over loaded, the circuit breaker will open. Immediately shut the machine down and check the dynatork circuit to locate and correct the cause leading to the over load. The circuit breaker is equipped with a trip lever very similar to the lever type of an ordinary light switch. When the cause of the overload is corrected it is only necessary to push the lever back to the "ON" position to reset the circuit breaker to the "ON" position.

DYNATORK TROUBLE SHOOTING GUIDE

Generator does not produce amperage:

(1) Check Brushes—
Check spring tension. If weak, replace spring.
Replace brushes if worn short.
Check brushes for freeness in brush holders. If not, free up.

(2) Check all connections at Terminals—
Tighten all loose connections.

(3) Check armature for dirty and worn commutator end—
If dirty, clean with fine sand paper.
If worn or grooved, have commutator trued up and undercut.

(4) Voltage Regulator out of calibration (Current regulator)—
If generator checks to be proper and all connections are tight then check voltage regulator. If proper instruments are not available regulator and generator should be taken to an authorized service station and calibrated, or regulator should be replaced.

Machine does not move in either direction:

(1) No power to field coils—
Check flow of power through Dynatork Drive to determine causes of lack of powers.

(2) Forward and reverse cables shorted together at brush holder—
If so, separate leads at this point.

Machine does not move in forward direction:

(1) Check voltage to forward brush terminal—
Connect volt meter to top terminal of brush holder mounting plate to ground. This being the forward brush, put directional switch in forward position. Volt meter should register approximately battery voltage, not to exceed one-half volt drop.

(2) Check forward brushes—
Check brushes for freeness in brush holders. If not, free up.
If worn short, replace.

(3) Check collector rings—
If dirty, clean with carbon tetrachloride.
If rough, smooth rings with fine sand paper.

(4) If there is power to forward brushes and brushes are free in brush holder and of proper length, and also are seating properly this would indicate that there is an opening in flywheel forward fields. In this case, flywheel assembly will have to be removed.

Machine does not move in reverse direction:

(1) Check in same manner as for condition in forward movement failure, using reverse circuit.

Machine loses torque and moves slowly:

(1) Check brushes—
Check and determine if brushes are seating properly. If not, replace.
Check brush spring tension. If not sufficient, replace the brush springs.
Check brushes to see if they are free in brush holders. Free up, if not.

(2) Check collector rings—
If collector rings are dirty they should be cleaned with carbon tetrachloride.
If collector rings are rough or pitted they should be cleaned and smoothed up with fine sand paper.

(3) Check caterpillar—
Check flow of current to and through caterpillar resistor. When all fingers are not making contact there will be a resistance in circuit.

If caterpillar is faulty, check as follows:

(1) Remove caterpillar by:
(a) Removing the cables from the input and output terminals.
(b) Removing the pin from the control arm adjustable linkage.
(c) Removing the caterpillar to frame mounting bolts.

(2) Disassemble the caterpillar
(a) Remove the four round head cap screws.
(b) Next remove the caterpillar assembly from the housing.

(c) The fingers should be in a parallel position to each other, with silver contact points all closed or touching each other.

(d) If any of the fingers are burnt or warped, this will let the current flow through the carbon resistors, thus reducing the torque and slowing down the speed of the machine. If this is the case, it is necessary to replace faulty parts or possibly adjust all blades so that they are parallel with contact points closed.

CAUTION: After installing caterpillar, check all electrical connections in drive circuit, making sure that there is not a fluctuation of voltage taking place.

ELECTRICAL SYSTEM

DISTRIBUTOR

a. Description. The distributor is located on the top of the engine and is driven by a shaft from gear on camshaft at one-half engine speed. The distributor cap is held on by spring clamps and has 4 connections for the spark plug wires and one for the coil wire.

b. Maintenance and Adjustment.

Preliminary Instructions. Release two distributor clamps. With screw driver remove screws

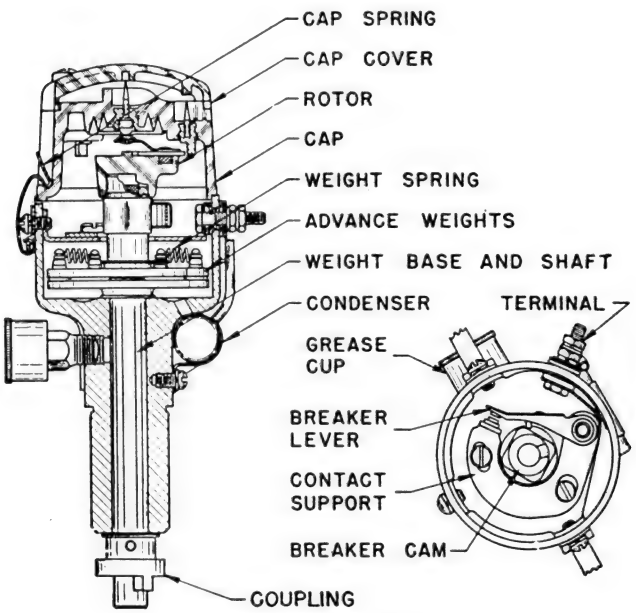


Fig. 58 — Distributor

holding distributor cap cover and remove spark plug wires marking each one for easy identification. Remove coil connecting wire. Remove rotor from distributor shaft.

Inspect Breaker Contacts. If breaker points are a grayish color and only slightly pitted they need not be replaced. Replace rough or badly pitted breaker contacts. In an emergency points may be cleaned with a clean fine cut file without removing from the distributor. A hone may also be used to resurface faces of contacts.

Distributor Cap. Visually inspect distributor cap for cracks, carbon streaks and corroded high

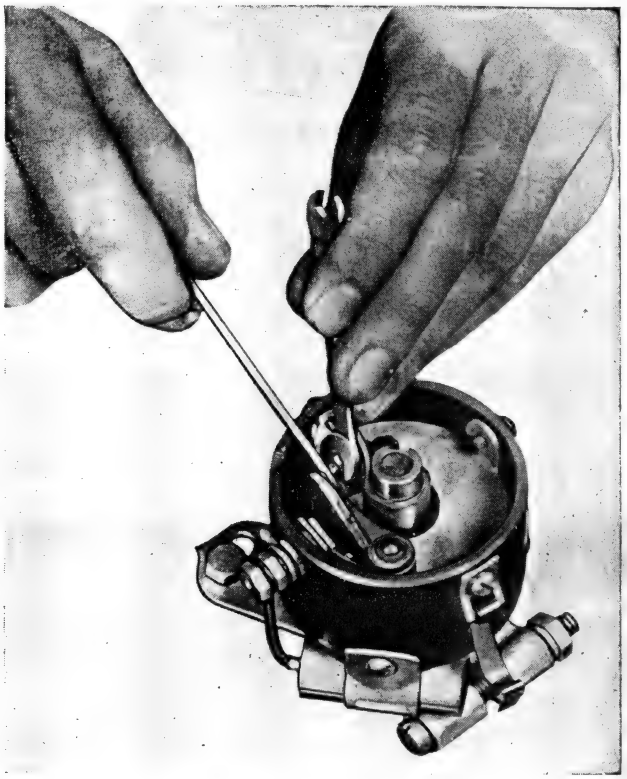


Fig. 59 — Checking Points

tension terminals. Replace cap if any of these conditions is found. Inspect the metal inserts on inside of cap. After a distributor has had normal use the vertical face of the inserts become slightly burned. **NOTE: DO NOT FILE.** If the burning is excessive replace the cap. Examine inserts for burning on horizontal faces. If burning is noticeable at this point it is an indication that gap between rotor and insert is too large. If this condition is found replace both cap and rotor.

Rotor. Inspect rotor for cracks and replace if cracked. After normal use the end of the metal strip may become slightly burned. If evidence of burning is found on top of metal strip, replace rotor and cap.

Condenser. In the absence of proper equipment to test this inexpensive but important unit, it will be best, in trouble shooting, to replace with a new condenser unit, where some doubt exists as to its condition.

Remove Condenser. Remove screw and lockwasher which hold condenser wire to breaker arm, then remove screw and lockwasher which holds condenser to breaker sub plate and remove condenser and wire.

Remove Breaker Points. With screw removed attaching breaker lever spring and condenser lead to part on breaker plate, remove clip holding breaker lever on hinge, compress breaker lever spring between thumb and forefinger, and lift breaker lever off pivot pin. Unscrew adjusting locking screw and lift off stationary contact point support.

Install Breaker Points. To install breaker points reverse above procedure.

Install Condenser. Replace and tighten screw and lockwasher which hold condenser wire to breaker arm. Replace and tighten screw and lockwasher that hold condenser to breaker sub plate.

Remove Distributor. Remove screw that holds distributor clamping plate to engine and remove distributor.

Install Distributor. Install distributor and replace screw and lockwasher in distributor clamping plate. Before tightening down screw, maneuver distributor by turning until projection on drive shaft collar drops into slot in end of drive shaft.

Set Breaker Point Gap. With distributor cap removed loosen screw nearest outside shell of distributor in stationary breaker point base. The hole through which this screw is placed is elongated, allowing for adjustment in two directions. A short distance from this screw and nearer center is another screw through same breaker point base. The head of this screw is elongated and fits in an elongated hole in base plate. To open or widen gap between breaker points, turn this screw (with aid of screwdriver) clockwise. To close turn counterclockwise. Be sure to retighten lower screw, holding new adjustment. Gap should be of width that will cause slight drag on feeler gage of .018 thickness.

End Play. With distributor removed check end play with feeler gauge between lower drive shaft coupling and gear spacer washer as shown in Fig. 60. Tolerable end play is from .003 to .010, and if an excess is found distributor should be replaced.

Fig. 60 — Checking Distributor Shaft End Play

SET IGNITION TIMING

In the event that lock plate become loose in regular service resulting in distributor getting out of time, it will be necessary to go through the following steps in order to retime engine. Only these three items are involved: the distributor, the Number One spark plug, and the timing hole in flywheel housing where dead center marking may be seen on flywheel.

Remove No. 1 spark plug which is the one nearest radiator.

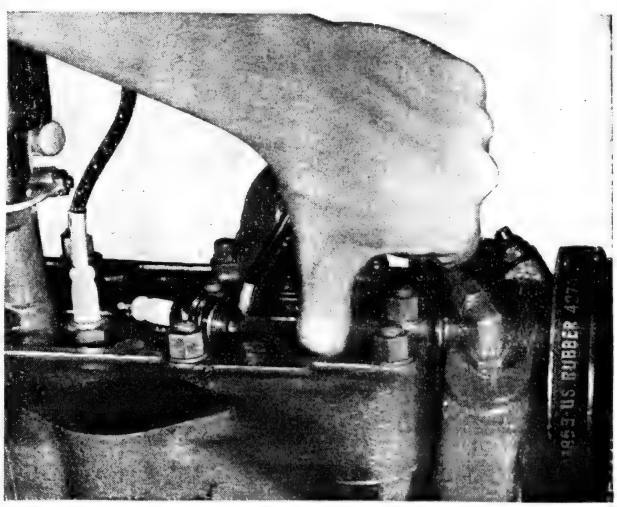


Fig. 61

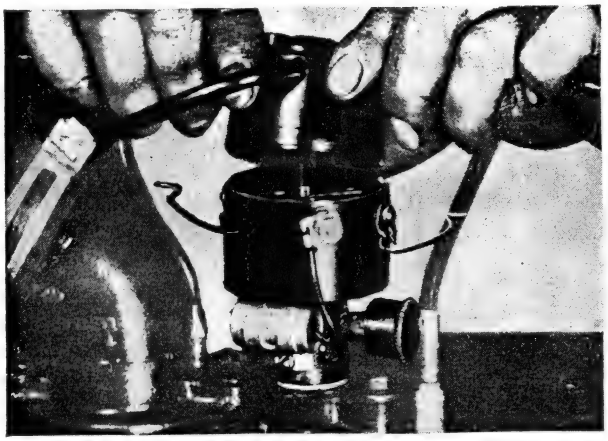


Fig. 62 — Remove Distributor Cap

Press thumb over hole left vacant by removal of the Number One spark plug as shown in Fig. 61. With thumb pressed over hole turn engine over slowly with the starter until you feel air whoosing up around your thumb. Stop turning over engine at this point, for it means that Number One piston is on the compression stroke and that it is nearing top dead center. Flash light into timing hole in flywheel housing and then continue to turn over engine slowly. When top dead center marking on flywheel appears in opening, center this mark on the pointer welded on the flywheel housing just inside the hole. See Fig. 62A. Now the Number One piston is on top dead center. With breaker points set at proper gap width remove lock plate screws and raise distributor enough to disengage driver gear and shaft. Now turn distributor shaft to a point where rotor points directly at the distributor cap post to which Number One spark plug is connected. Lower distributor to reengage drive gear and shaft, maintaining position of rotor pointing at the distributor cap post to which Number One spark plug wire is connected. Turn distributor shell to left or in a counterclockwise direction, with rotor remaining in a fixed position until breaker points are barely separated. Tighten lock plate screws to hold distributor outer stationary parts in this relation to inward moving parts. If engine seems sluggish and it is thought to be caused by too slow timing, loosen distributor clamp plate screw and turn distributor shell slightly to right or in a clockwise direction. Turn to left or in a counter-clockwise direction to retard spark. Tighten screws in distributor clamp plate before starting engine.

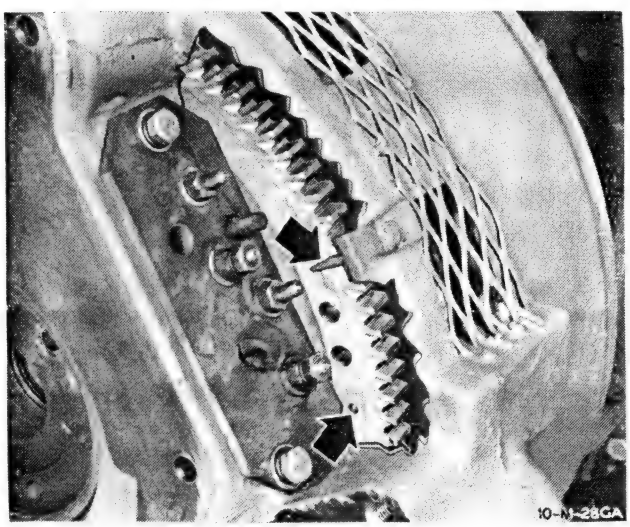


Fig. 62A

IGNITION COIL

Description. The ignition coil is located on the back of sump tank and is held in place by a clamp and two nuts. It is connected to the battery by a wire to its low tension side and by a wire to the distributor from its high tension side. The ignition coil is used to transform the low voltage supplied by the battery into the high voltage energy necessary to jump the spark plug gaps.

Removal. Disconnect wire from battery and pull out wire from center of coil cap. Unscrew nuts holding coil to sump tank. Coil may be removed.

Installation. Install coil against sump tank in correct location and re-install screws, washers and nuts. Reconnect wires.

STARTING AND GENERATOR SYSTEM

Description. The starting and generating system consists of the generator, voltage, regulator, starting motor and starting switch. The generator supplies electrical energy to the storage battery to maintain it in a charged condition. The voltage regulator is between the generator and battery and regulates the generator output to the battery. The starting motor is controlled by the starter switch located conveniently for the driver on the seat plate.

DATA:

Generator:

Make ..... Autolite
Make ..... Delco-Remy
Type ..... Two Brush

Voltage Regulator:
Make ..... Autolite
Make ..... Delco-Remy
Type ..... Three Unit

Starting Motor:
Make ..... Autolite
Make ..... Delco-Remy
Type ..... Bendix drive

Starter Switch
Make ..... Autolite
Make ..... Delco-Remy
Volts 6
Ventilated ..... No
Control . . . . Third brush and two charge regulator
Poles 2
Bearings ..... Bronze at commutator end.
Ball at drive end.

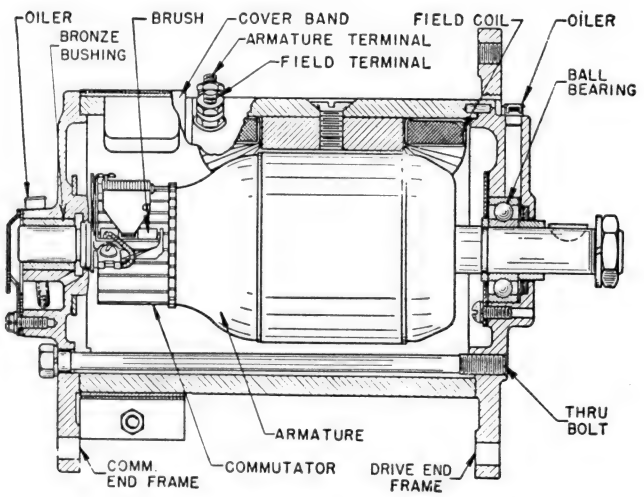


Fig. 63 — Sectional View Generator

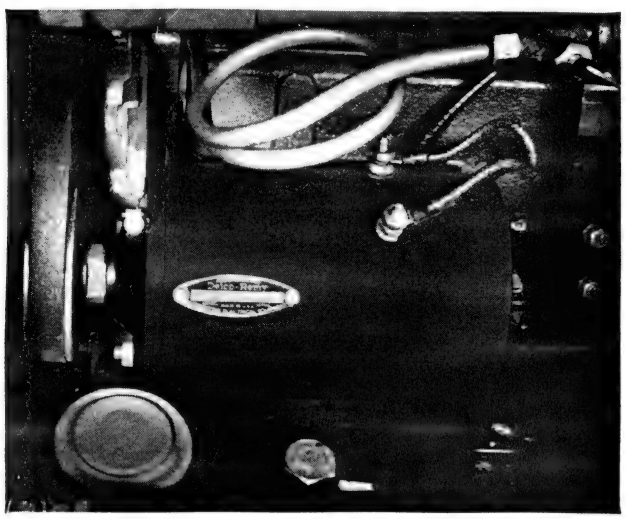


Fig. 64 — Generator

The Generator is a 6 volt, $4\frac{7}{16}$-inch frame diameter, third brush unit, with a ball bearing in the drive end and a bronze bushing in the commutator end. A three unit voltage control is used with this generator.

Field current at 6 volts	**Cold Output**
at 80 F Amp. 1.76-1.95	50 Amps 7.5
Maximum output controlled by current regulator	Volts 1410 RPM

Removal. Remove generator strap so generator can swing in toward engine. Loosen generator hinge screws. Push generator toward engine, loosening drive belt sufficiently so that belt can be slipped out of generator pulley. Remove wires from generator and remove generator hinge screws, holding on to generator to prevent dropping.

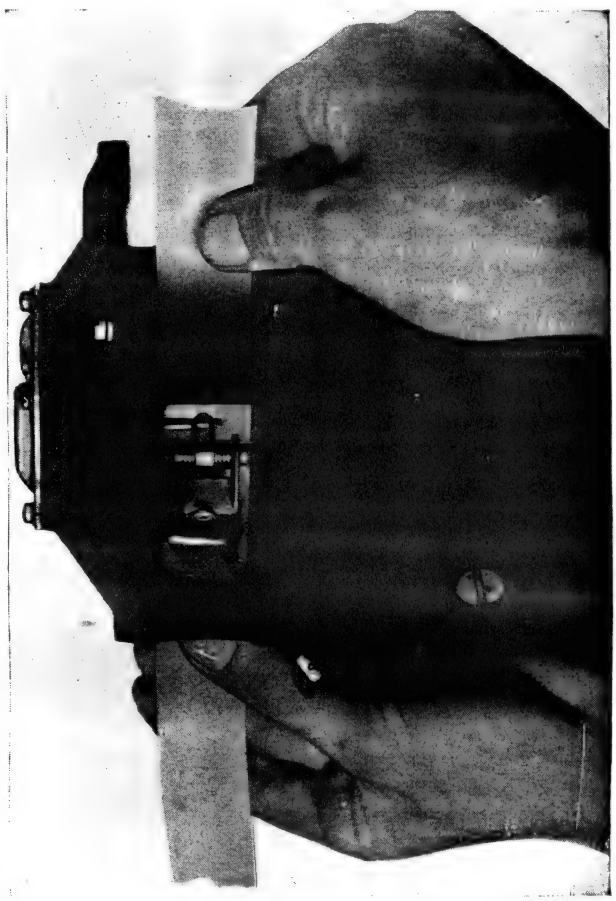


Fig. 65 — Cleaning Commutator

Generator Maintenance. Generator maintenance may be divided into two sections, **normal maintenance** required to assure continued operation of the generator and the **checking and repair of inoperative generator.**

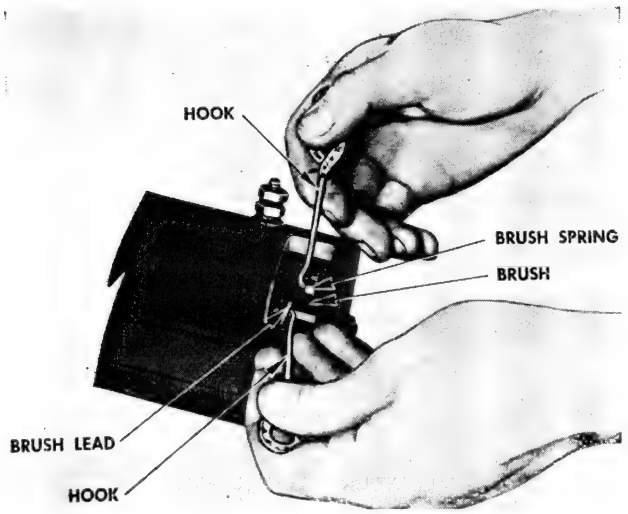


Fig. 66 — Removing Brushes

Inspection — The cover band should be removed and the commutator and brushes inspected at regular intervals. If the commutator is dirty, it may be cleaned with No. 00 sandpaper.

Blow out dust. **NEVER USE EMERY CLOTH TO CLEAN COMMUTATOR.** If the commutator is rough, out of round, or has high mica, it should be turned down in a lathe and the mica undercut.

Worn brushes should be replaced. They can be seated with a brush seating stone. The brush seating stone is an abrasive material which, held against the revolving commutator, carries under and seats the brushes in a few seconds. Blow out dust. NEVER USE EMERY CLOTH.

GENERATOR DISASSEMBLY

At regular intervals, or time depending on type of operation, the generator should be disassembled for a thorough cleaning and inspection of all parts. Never clean the armature or fields in any degreasing tank, or with grease dissolving materials, since these may damage the insulation. The ball bearing at the drive end should be cleaned and repacked with a good grade of ball bearing grease.

Fig. 67 — Checking Generator Brush Spring Tension

The commutator should be trued in a lathe and the mica undercut if necessary. All wiring and connections should be checked. Resin flux should be used in making all soldered connections. Acid flux must never be used on electrical connections.

CHECKING INOPERATIVE GENERATOR

Several conditions may require removal of the generator from the engine and further checking of the generator, as follows:

No Output
Unsteady or Low Output
Excessive Output
Noisy Generator

NO OUTPUT

Remove cover band and check for sticking or worn brushes and burned commutator bars. Burned bars, with other bars fairly clean, indicate open circuited coils. If brushes are making good contact with commutator and commutator looks okay, use test leads and light and check as follows:

Raise grounded brush, check with test points from "A" terminal to frame. Light should not light. If it does, the generator is grounded; raise other brushes from commutator and check field, commutator and brush holder to locate ground.

If generator is not grounded, check field for open circuit.

If the field is not open, check for shorted field. Field draw at six volts should be three and five-tenths to four and five-tenths amperes. Excessive current draw indicates shorted field.

If trouble has not yet been located, remove armature and check on growler for short circuit.

UNSTEADY OR LOW OUTPUT

Check as follows:

Check brush spring tension and brushes for sticking.

Inspect commutator for roughness, grease and dirt, dirt in slots, high mica, out of round, burned bars. With any of these conditions, the commutator must be turned down in a lathe and the mica undercut. In addition, with burned bars which indicate open circuit, the open circuit condition must be eliminated or the armature replaced.

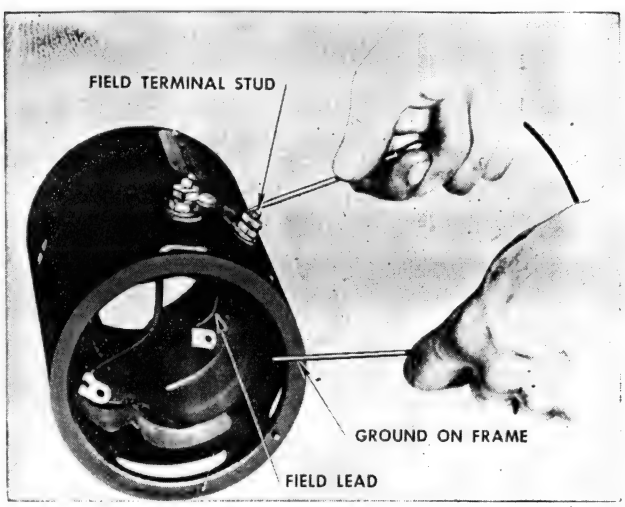


Fig. 68 — Checking Generator for Grounded Leads

EXCESSIVE OUTPUT

Excessive output usually results either from wrong adjustment of the third brush or from the grounded generator field — grounded either internally or externally. Opening the field circuit (disconnecting lead from "F" terminal of generator) with generator operating at a medium speed will determine if the generator is at fault.

If the output drops off, the field is grounded externally. If the output remains high, the field is grounded in the generator, either at the pole shoes, leads, or at the "F" terminals.

NOISY GENERATOR

Noisy generator may be caused by loose mounting, worn or loose coupling, worn, dry or dirty bearings, or improperly seated brushes. Brushes may be seated by using brush seating stone.

INSTALLATION CAUTION

After the generator is reinstalled on the engine, or at any time after leads have been disconnected and then reconnected to the generator, a jumper lead should be connected MOMENTARILY between the BATTERY and GENERATOR terminals of the voltage regulator **before starting the engine.** This allows a momentary surge of current from the battery to the generator which correctly polarizes the generator with respect to the battery it is to charge.

INSTALLATION

To install generator hold generator between end holes of generator bracket and insert hinge screws and washers. Tighten just enough to support generator safely. Put generator belt on generator pulley. Holding generator out from engine so that belt is drawn snug, tighten hinge screws. Test generator belt for play. It should have ½" play at right angle to line of travel. When properly adjusted for belt tension replace generator suspension strap to help hold this position. Replace wires.

VOLTAGE REGULATOR

The voltage regulator consists of these units, the current regulator, the voltage control and the cut-out relay. These must be so adjusted and balanced that battery may be maintained at full strength under normal conditions without danger or injury to battery due to over charging. The voltage regulator should not be disassembled. The adjustment of the units of the voltage regulator are very deli-

cate and must be made with great precision in order to obtain correct operation of the regulator. Actually only a few parts can be removed from the unit and if trouble develops from this source replace the complete unit.

DATA

CURRENT REGULATOR

Setting Range	48-52 Amps. (Adjust to 50)
Air Gap	.075 in.
Cut-out Relay Unit	
Air Gap	.020 in (point closed)
Point Opening	.020 in.
Closing Voltage	5.9-6.8 V at 70°F (Adjust to 6.4 V)
Voltage Regulator	
Air Gap	.075 in.
Points Open	7.0-7.7 V at 150°F (Adjust to 7.4 V)

CHECKS AND ADJUSTMENTS

CURRENT REGULATOR

Two settings are required on the current regulator. To check the air gap, push armature down until the contact points are just touching, then measure their gap. Adjust by loosening the contact mounting screws and raising or lowering the contact bracket as required. Be sure the points are lined up and tighten screws after adjustment. To check current regulator setting the voltage regulator must be prevented from operating. An ammeter must be connected into the charging circuit at the regulator "BAT" terminal. A quick check method with the regulator mounted on the machine, insert a screw driver blade through the oblong hole in base of regulator until contact is made with shield around resistor. See Fig. 69. Be sure to keep screw driver at right angles to base, and hold firmly in place during check so that blade touches regulator base and shield at same time. This temporarily cuts out voltage regulator unit. With lights on (when machine is so equipped) to help prevent high voltage during test, and ammeter connected, operate generator at 50 per cent above rated output speed, and note current setting. If adjustment is necessary remove cover and turn adjusting screw clockwise to increase current setting or counterclockwise to decrease setting.

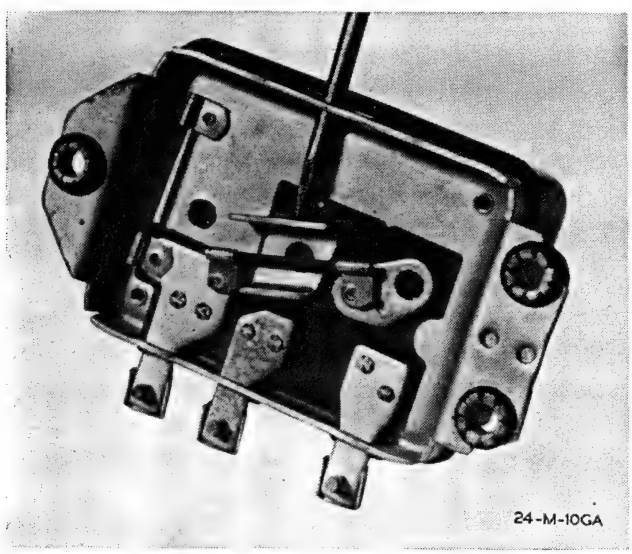


Fig. 69 — Voltage Regulator

CAUTION:

If adjusting screw is turned down (clockwise) beyond normal adjustment range, spring support may fail to return when pressure is relieved. In such case turn screw counterclockwise until sufficient clearance develops between screw head, and spring support, then bend spring support upward carefully with small pliers until contact is made with screw head. Final setting of the unit should always be approached by increasing spring tension, never by reducing it. If setting is too high, adjust the unit below required value then raise to exact setting by increasing spring tension. If a unit is badly out of adjustment spring should be replaced.

VOLTAGE REGULATOR ADJUSTMENT

Check and if necessary, set air gap between armature and core to .075 in. Then set the contact

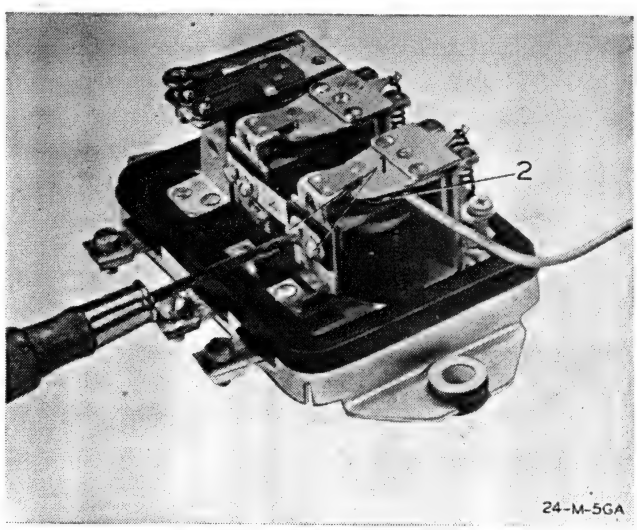


Fig. 70 — Voltage Regulator

point opening to .020 inches by bending the armature stop.

Connect a voltmeter between the generator terminal of the control unit and ground. Fig. 70 shows voltage regulator air gap check and adjustment. Use round wire feeler gauge as illustrated.

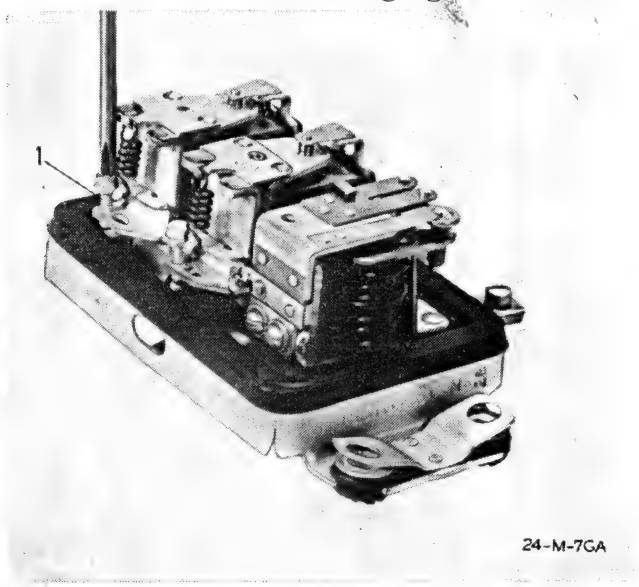


Fig. 70A

Adjust the relay so the points will close when the generator voltage reaches 7.0 to 7.7 by raising or lowering the spring post. Raising the spring post increases the closing voltage. Fig. 70A shows the voltage regulator setting adjustment.

With an accurate ammeter in the charging circuit, the relay points should open when the ammeter reads between 0-4.0 A.

CUT OUT RELAY

The cutout relay requires three checks and adjustments: Air gap, point opening and closing voltage. The air gap and point opening adjustments must be made with the battery disconnected.

AIR GAP . See Fig. 70B.

Place fingers on armature directly above core and move armature down until points just close and then measure air gap (2) between armature and center of core. To adjust air gap, loosen two screws (1) at back of relay and raise or lower the armature as required. Tighten screws after adjustment.

POINT OPENING

Check point opening and adjust by bending the upper armature stop. See Fig. 70 C.

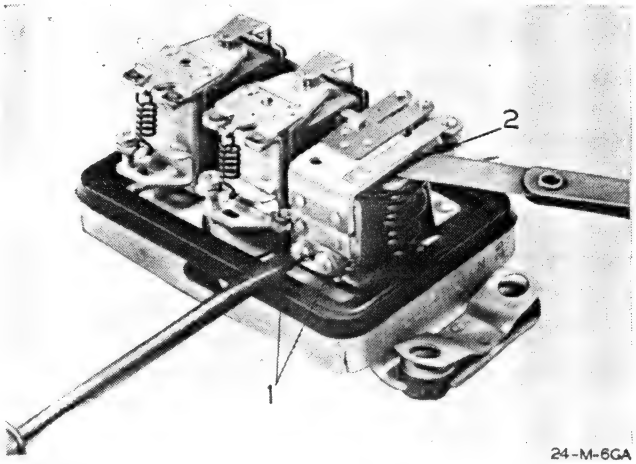


Fig. 70B

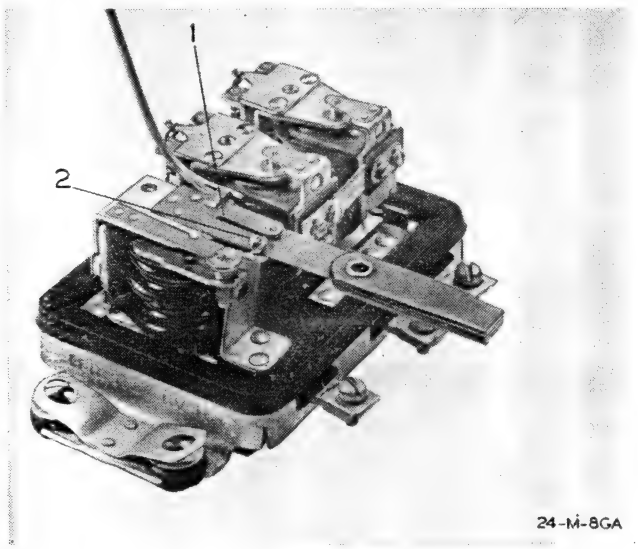


Fig. 70C

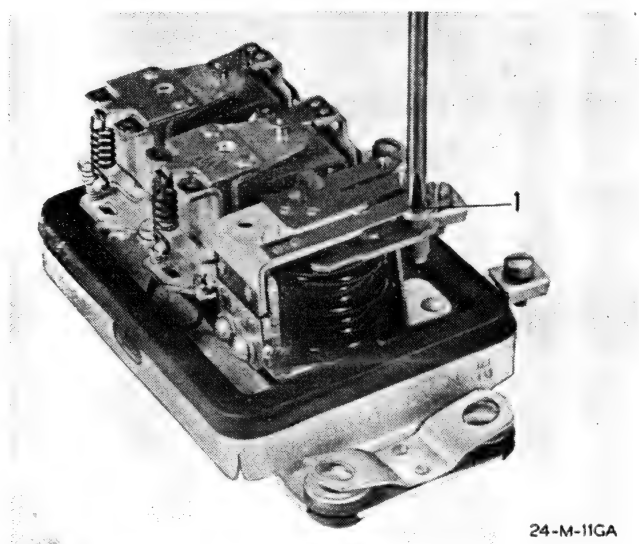


Fig. 70D

CLOSING VOLTAGE

To check the closing voltage of the cutout relay, connect the regulator to the proper generator and battery leads, connect a voltmeter between the regulator "GEN" terminal and regulator base, and connect an ammeter into the charging circuit at the regulator "BAT" terminal. Slowly increase the generator speed and note relay contact points open. Adjust closing voltage by turning adjusting screw. See Fig. 70 D, Ref. 1. Turn screw clockwise to increase spring tension and closing voltage and counterclockwise to decrease closing voltage.

REGULATOR SPRING REPLACEMENT

If it becomes necessary to replace the spiral spring on either the current or voltage regulator unit, the new spring should first be hooked on the lower spring support then stretched up until it can be hooked at the upper end. Stretch the spring only by means of a screw driver blade inserted between the turns (or in a similar manner). Do not pry spring into place as this is likely to bend the spring supports. After installing a new spring, readjust the unit setting as described in foregoing paragraph.

CLEANING CONTACT POINTS

The contact points of a regulator require attention from time to time, the interval depending upon operating conditions and adjustments. A great deal of regulator trouble can be eliminated by cleaning the contact points with some possible readjustment. The flat points should be cleaned with a spoon or riffler file. See Fig. 70 E. On negative ground regulators which have flat contact point on the regulator armatures loosen the contact bracket mounting screws so they can be tilted to one side. A flat file cannot be used successfully to clear flat contact point since it will not touch the center of the flat point where point wear is most apt to occur. NEVER USE EMERY CLOTH OR SAND PAPER TO CLEAN THE CONTACT POINTS.

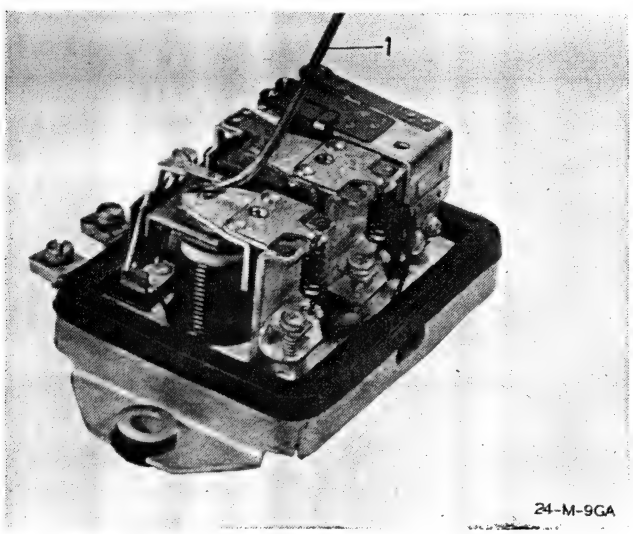


Fig. 70E

STARTING MOTOR

Description. The starting motor is located on the right side of engine when facing toward drive axle. It is secured to the flywheel housing by three cap screws. It extends into hole in flywheel housing at this point and the Bendix gear with which this unit is equipped engages with flywheel ring gear to turn the engine over for starting.

The Starting Motor is a four-pole, two-field, six-volt unit. It is mounted on the flywheel housing by a Number One S.A.E. flange. The armature rotates in a grey iron bearing at commutator end and an oilless bushing in the center bearing plate and in the pinion housing. The Bendix drive, keyed to the armature shaft, automatically engages the cranking pinion with the flywheel ring gear when the cranking motor armature begins to revolve. When the engine fires the overrunning effect of the flywheel on the pinion disengages it from the flywheel.

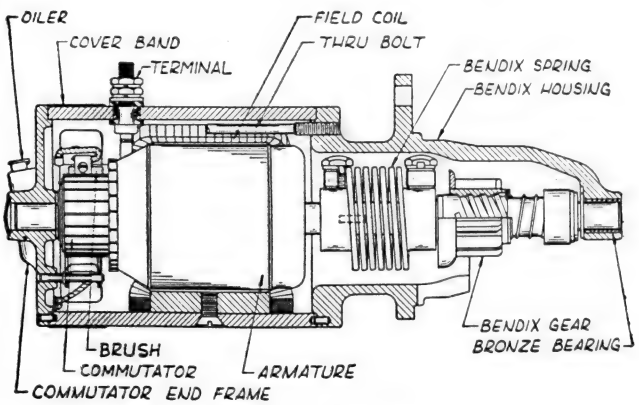


Fig. 71 — Starter

The starting motor specifications are:

Clockwise rotation viewing drive end.
Brush spring tension—24-28 ounces.
No load — 5000 r.p.m. — 65 amps. — 5.0 volts.
Lock torque — 12 ft. lbs. — 525 amperes — 3.37 volts.

Starter — Removal and Installation.

Turn steering wheels out of the way, remove starter cable from starter post, located on right

side of the engine, remove three capscrews from starter to flywheel housing, removing starter assembly from the bottom of machine.

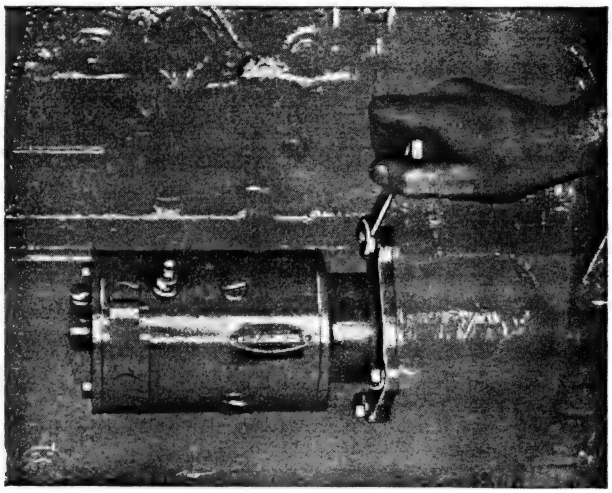


Fig. 72 — Starter

STARTING MOTOR MAINTENANCE

Starting motor maintenance may be divided into two sections, normal maintenance required to assure continued operation of the starting motor and the checking and repair of inoperative units.

NORMAL MAINTENANCE

Lubrication—The hinge cap oiler on the commutator end frame should be supplied with eight-ten drops of light engine oil at periodic intervals. (One hundred fifty hours of operation). During reassembly of the unit, when disassembled, a few drops of light engine oil should be applied to the bushing in the pinion housing. Apply a thin coating of graphite grease on shaft under pinion before assembling the Bendix drive.

Inspection—The cover band should be removed and the commutator and brushes inspected at a regular interval. If the commutator is dirty, it may be cleaned with No. 00 sandpaper. Blow out dust. Never use emery cloth to clean commutator. If the commutator is rough, out of round, or has high mica, it should be turned down on a lathe. Worn brushes should be replaced. If brushes wear rapidly, check for excessive brush spring tension and roughness or high mica on the commutator.

STARTING MOTOR DISASSEMBLY

At regular intervals, the actual time depending on the type of operation, the starting motor should be disassembled for a thorough cleaning and inspection of all parts. The Bendix drive should be cleaned and oiled with a penetrating oil, as any accumulation of dirt on the drive might restrict the free movement of the pinion. Never clean the armature of fields in any degreasing tank, or with grease dissolving materials, since these may damage the insulation. The commutator should be trued in a lathe if necessary. Replace all parts showing excessive wear. All wiring and connections should be checked. Rosin flux should be used in making soldered connections. Acid flux must never be used on electrical connections. Submit reassembled unit to NO-LOAD and LOCK tests.

CHECKING OF IMPROPERLY OPERATING STARTING MOTOR

If the starting motor does not develop rated torque and cranks the engine slowly or not at all, check the battery, battery terminals, and connections, and battery cables. Corroded, frayed, or broken cables should be replaced and loose or dirty connections corrected. The starting motor switch should be checked for burned contacts and the switch contacts cleaned or replaced if necessary.

If all these are in order, remove the cover band of the starting motor and inspect the brushes and commutator. The brushes should form good contact with the correct brush spring tension. A dirty commutator can be cleaned with a strip of No. 00 sandpaper held against the commutator with a stick while the starting motor operates. NEVER USE EMERY CLOTH TO CLEAN COMMUTATOR. If the commutator is very dirty, or burned, or has high mica, remove the armature from the starting motor and take a cut off the commutator in a lathe.

If there are burned bars on the commutator, it may indicate open circuited armature coils which will prevent proper cranking. Inspect the soldered connections at the riser bars. An open armature will show excessive arching at the commutator bar which is open, on the no-load test.

Tight or dirty bearings will reduce armature speed or prevent the armature from turning. A worn bearing, bent shaft, or loose field pole screws will allow the armature to drag on the pole shoes, causing slow speed or failure of the armature to revolve. Check for these conditions.

If the brushes, brush spring tension and commutator appear in good condition, the battery and external circuit found satisfactory, and the starting motor still does not operate correctly, it will

be necessary to remove the starting motor for no-load and torque checks.

NO LOAD TEST

Connect the starting motor in series with a battery of the specified voltage and an ammeter capable of reading several hundred amperes. If an r.p.m. indicator is available read the armature r.p.m. in addition to the current draw.

TORQUE TEST

It is advisable to use in the circuit a high current carrying variable resistance, so that the specified voltage at the motor can be obtained. A small variation of the voltage will produce a marked difference in the torque developed.

Interpreting results of No-load and Torque Tests.

Rater torque, current draw and no load speed indicates normal conditions of starting motor.

Low free speed and high current draw with low developed torque may result from:

Tight, dirty, or worn bearings, bent armature shaft or loose field pole screws which would allow the armature to drag.

Shorted armature. Check armature further on growler.

A grounded armature or field. Check by raising the grounded brushes and insulating them from the commutator with cardboard and then checking with a test lamp between the insulated terminal and the frame. If test lamp lights, raise other brushes from commutator and check fields and commutator separately to determine whether it is the fields or armature that is grounded.

Failure to operate with high current draw:

A direct ground in the switch, terminal or fields.

Frozen shaft bearings which prevent the armature from turning.

Failure to operate with no current draw:

Open field circuit. Inspect internal connections and trace circuit with a test lamp.

Open armature coils. Inspect the commutator for badly burned bars. Running free speed, an open armature will show excessive arcing at the commutator bar which is open.

Broken or weakened brush springs, worn brushes, high mica on the commutator, or other causes which would prevent good contact between the brushes and commutator bars.

Low no-load speed, with low torque and low current draw indicates:

An open field winding. Raise and insulate ungrounded brushes from commutator and check field with test lamp.

High internal resistance due to poor connections, defective leads, dirty commutator and causes:

High free speed with low developed torque and high current draw indicates shorted fields. There is no easy way to detect shorted fields, since the field resistance is already low. If shorted fields are suspected, replace the fields and check for improvement in performance.

Installation. Install gear end of starter in flywheel housing opening and line up holes in correct position. Hold unit with one hand and turn up capscrews and lockwashers as far as possible with fingers. Apply wrench and tighten screws securely. Attach wire from starter switch to starting motor terminal.

STARTER SWITCH

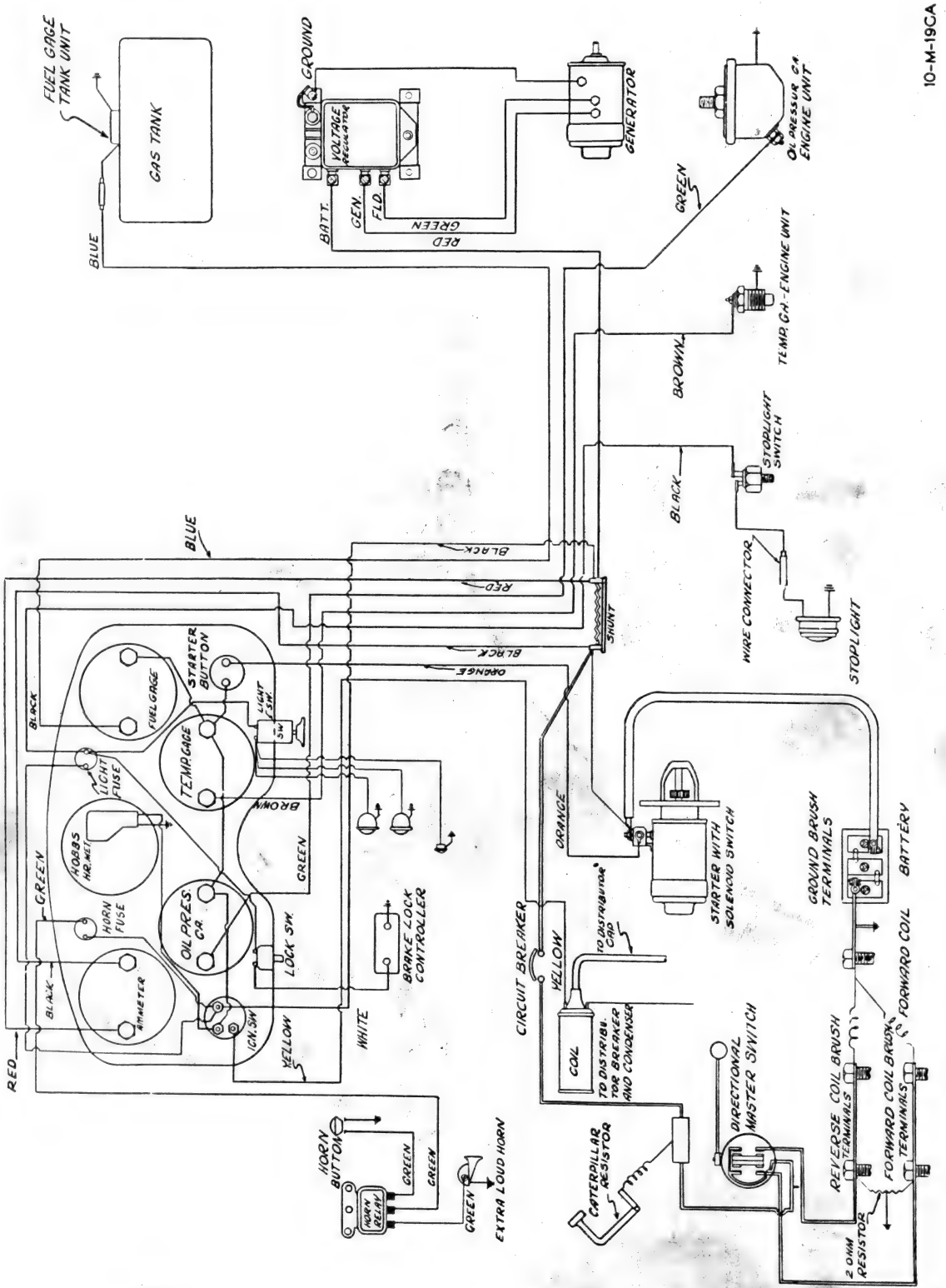
Description and Data. The starter switch is mounted on the instrument plate and is pushed in by fingers to make contact. It is constructed with a compression spring to disengage contact after each contact is made. After considerable use contact copper block may become burned out enough on one side by arcing as contact is made or broken to affect the efficient working of this unit. When this happens contact block may be reversed, bringing new surface into contact.

BATTERY

Description. The battery is a 6 volt, 15 plate, wet, long type and is located in rear wheel counterweight well on driver's seat. It should require no attention other than cleaning and drying outside of battery, and cleaning corrosion from battery terminal at end of battery cables. Battery negative and positive terminal posts should also be cleaned of all corrosion and lightly covered with cup grease before cables are reinstalled. Electrolyte solution in battery should be maintained at correct level by regular addition of pure distilled water to each cell. The level of the battery solution should be checked every week for every 48 hours of operation.

Removal. Remove the two screws from the battery cover and remove cover. Remove the two bolts and nuts from each of the two battery clamps and remove clamps. Remove battery cables.

Installation. Reverse above procedure in installing battery.



10-M-19CA

Fig. 72A

SPARK PLUG

The purpose of the spark plug is to ignite the fuel-air mixture in the combustion chamber. The spark plug carries the high-voltage from the distributor to the plug's positive electrode. The high voltage spark then jumps the gap to the negative electrode which is grounded to the engine.

Spark plug specifications for correct gap should be closely followed to insure efficient operation. (Setting is .025".) The exterior of the spark plug should be kept clean. If moisture or other material is allowed to accumulate on the insulated part of the plug, it may cause the plug to misfire. The spark may follow the accumulated moisture or dirt down the outside of the plug to the ground, rather than jumping the gap inside the combustion chamber.

ELECTRICAL SYSTEM TROUBLE SHOOTING GUIDE

FAULTY IGNITION

CAUSES

1. Primary circuit
   a. Wiring
      1. Loose or corroded terminals.
      2. Insulation cracked or worn through.
      3. Faulty ground connection.
   b. Ignition switch
      1. Loose contacts.
      2. Corroded or burned contacts.
   c. Distributor
      1. Ignition not properly timed.
      2. Distributor points not properly spaced.
      3. Distributor points coated (due to excessive arcing), dirty, pitted or loose.
      4. Sticking breaker arm or broken arm spring.
      5. Low cam lobe.
      6. Excessive clearance of distributor shaft bushings.
      7. Bent or sprung distributor shaft.
   d. Condenser weak or grounded.
2. Secondary circuit
   a. Wiring
      1. Corroded or loose terminals.
      2. Cracked or leaking cable insulation.
   b. Distributor
      1. Cracked distributor cap.
      2. Moisture or dirt accumulation in distributor cap.
      3. Distributor cap terminals burned or corroded.
      4. Distributor rotor burned or corroded.
   c. Weak ignition coil.
   d. Faulty or incorrectly spaced spark plugs.

DISTRIBUTOR—INCORRECTLY ADJUSTED OR DAMAGED

CAUSES

1. Breaker point gap incorrect.
2. Breaker points burned, cracked, pitted or dirty.
3. Ignition timing too late or too early.
4. Distributor cap cracked.
5. High tension cable sockets corroded.
6. Condenser open or shorted (check with new condenser).
7. Breaker arm spring weak or broken.
8. Breaker arm rubbing block loose or badly worn.
9. Breaker arm plate loose or not properly grounded.
10. Distributor cap inserts bent, loose or badly burned.
11. Insufficient clearance between distributor cap inserts and rotor.
12. Grounded rotor or broken rotor spring.
13. Distributor shaft or bushings worn.
14. Distributor drive gear or coupling sheared or loose on shaft.
15. Distributor drive gear or oil pump drive gear not properly assembled (timed).

IGNITION COIL DIFFICULTIES

CAUSES

1. Primary winding.
   a. Shorted (ignition current draw abnormally large—weak spark).
   b. Grounded (ignition current does not drop to zero when contacts separate).
2. Secondary winding shorted or grounded (weak spark).
3. Loose or faulty ignition switch contacts.
4. Loose contact of distributor to coil secondary cable in coil tower.
5. Use of a coil other than standard equipment.

SPARK PLUG DIFFICULTIES

CAUSES

1. Plug does not fire or spark is weak.
   a. Porcelain cracked.
   b. Porcelain carbonized or burned.
   c. Moisture or dirt accumulation on porcelain.

d. Electrode gap not properly spaced (spark will not jump at high speed).
e. Weak ignition coil.

2. Electrodes and porcelain burn in short time.
   a. Use of too hot an operating plug.
   b. Use of certain types of gasoline having a detrimental effect on porcelain.
3. Fouled plugs.
   a. Use of too cold an operating plug.
   b. Excessively rich carburetor mixture.
   c. Engine oil passing piston rings.

STARTING MOTOR INOPERATIVE OR NOT OPERATING PROPERLY

CAUSES

1. Dead or undercharged battery.
2. Poor battery ground or corroded battery terminals.
3. Starting motor to battery cable broken or terminal cracked.
4. Teeth or starter pinion or flywheel broken.
5. Use of heavy engine oil in cold weather.
6. Teeth on starter pinion or flywheel burred, causing starter to stick.
7. Poor ground for starting motor due to broken ground cable.
8. Starting switch not operating properly.
9. Excessive resistance to rotation due to:
   a. Bent armature shaft.
   b. Distorted or cracked housing.
   c. Misaligned or tightly fitted bearing.
   d. Lack of lubrication.
   e. Starter not properly aligned with engine.
10. Armature shorted.
11. Dirty, burned, pitted, or excessively lubricated commutator surface.
12. High mica between commutator segments due to commutator wear.
13. Brush ring grounded or set incorrectly.
14. Excessive brush spring tension causing rapid commutator and brush wear.
15. Brushes not functioning properly due to:
   a. Sticking brush holders.
   b. Weak or broken springs.
   c. Bent brush holder arms.
   d. Brushes worn too short.
   e. Brushes sticking in guides.
   f. Incorrect type of brushes.
   g. Brush connections or pig tails loose.

STARTER DRIVE NOISES

DESCRIPTION

The most common starter drive noise due to causes No. 1, 2, and 5 is a pronounced grind when the starter motor is operating. This grind is similar to, but louder than, the normal starter noise when the engine is being cranked and should not be confused. A hissing noise will indicate cause No. 3, while cause No. 4 will be indicated by an intermittent rubbing noise. If the starting motor is not rigidly attached, a knock or "bump" will be heard when the started pinion engages.

CAUSES

1. Starter pinion teeth chipped or damaged.
2. Flywheel gear teeth chipped or damaged.
3. Sprung or distorted drive shaft.
4. Starter motor not properly mounted (misaligned).
5. Starter motor loose on engine.
6. Starter motor armature shaft bearing worn broken or dirty.

GENERATOR INOPERATIVE OR NOT CHARGING PROPERLY

CAUSES

1. Slipping belt.
2. Armature indicates incorrect or no charging rate (check with master ammeter).
3. Generator pulley loose on shaft.
4. Relay points remaining open.
5. Incorrect size generator drive pulley.
6. Too low an engine idle speed.
7. Improper regulator operation.
8. Greasy, charred, or glazed commutator.
9. Sticking brush holder arms—brushes worn too short.
10. Brushes soft or oily (excessive lubrication).
11. Shorted, open, or burned out field coils.

GENERATOR AND GENERATOR DRIVE NOISES

DESCRIPTION

The most common of generator noises is a squeak resulting from causes No. 1 and 2. Causes No. 3 and 7 are usually indicated by a knock at low speed although cause No. 3 may sometimes also cause a squeak. An intermittent knock increasing in frequency as the speed is increased will indicate cause No. 4. A whine usually indicates causes No. 6 and 8.

CAUSES

1. Worn, damaged, or defective generator bearing.
2. Insufficient bearing lubrication.
3. Pulley loose on shaft.
4. Cracked pulley.
5. Excessive end play of generator shaft.
6. Misalignment of generator belt.
7. Generator loose on engine.
8. Generator brush noises resulting from:
   a. High mica insulators between commutator bars.
   b. High commutator bars.
   c. Rough commutator.
   d. Dirty commutator.
   e. Improperly seated brushes.
   f. Hard spots in generator brushes.
   g. Insufficient or excessive brush spring tension.
   h. Generator brushes loose in holder.
   i. Loose field magnets striking armature.

FREQUENT RECHARGING OF BATTERY NECESSARY

CAUSES

1. Insufficient current flow to battery.
   a. Inoperative generator.
   b. Too low an engine idle speed.
   c. Loose connections in external circuit.
   d. Corroded connections in external circuit (especially at battery terminals and frame ground strap).
   e. Slipping belts.
   f. Incorrect size generator drive pulley.
   g. Regulator out of adjustment.
   h. Ammeter registering higher charging rate than actual (check with master ammeter).
2. Excessive starting load causing abnormal current flow from battery.
   a. Frequent use of starter motor.
   b. Excessive use of the starter motor due to difficulty in starting.
   c. High mica between commutator bars or badly worn or burned commutator.
3. Internal discharge of battery.
   a. Plates badly sulphated.
   b. Cell leak due to cracked jar or sealing compound.
   c. Water level not at proper height.
   d. Plate separators ineffective.

NOTES

ENGINE

DESCRIPTION

The engine is a four cylinder, Continental, internal combustion gasoline engine of the L head type with an SAE rating of 16.3 horsepower.

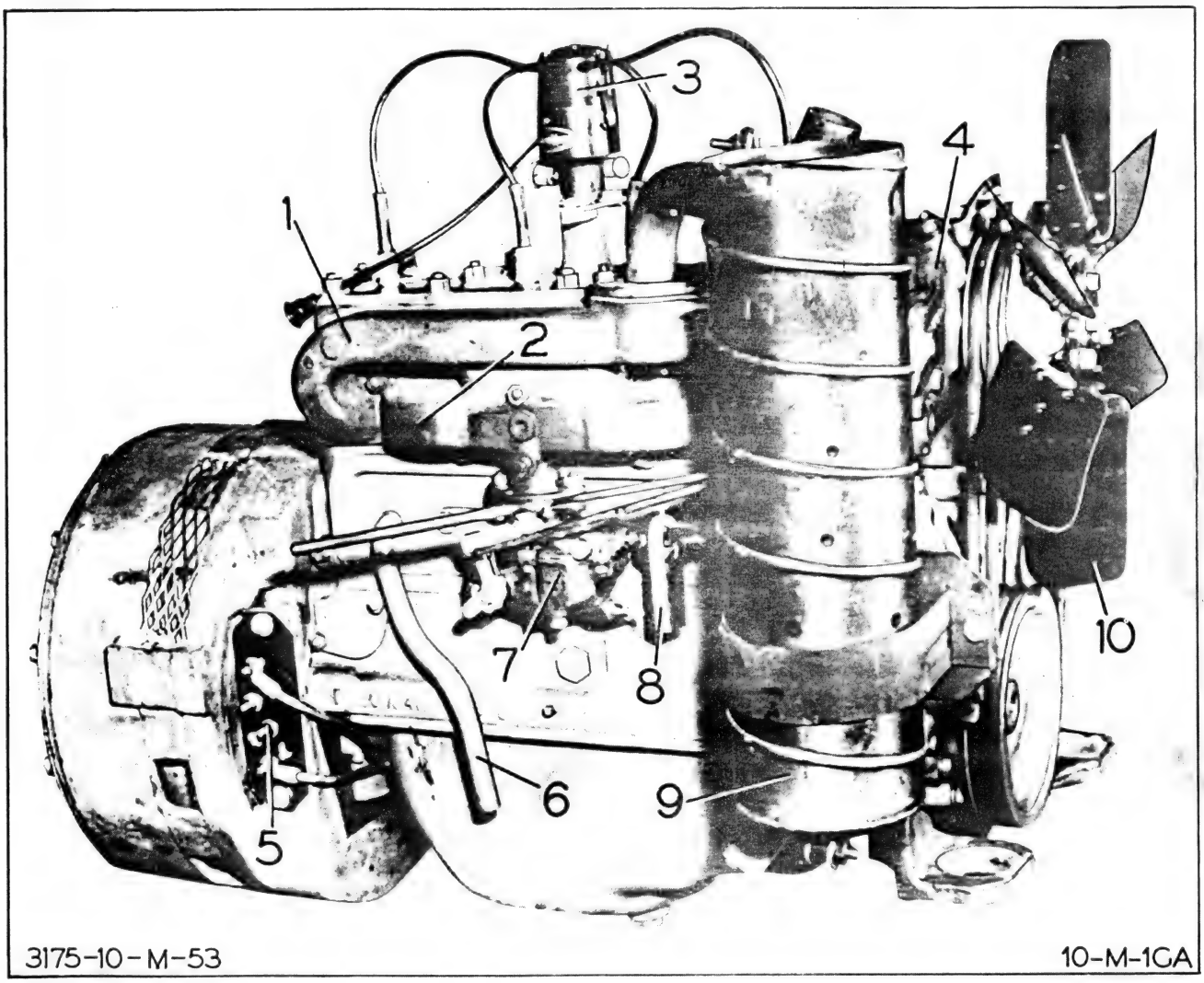
DATA

Make.....Continental
Model.....F-4140

Bore.....3 3/16 in.
Stroke.....4 3/8 in.
Firing Order.....1-3-4-2
Displacement.....139.6 cu. in.

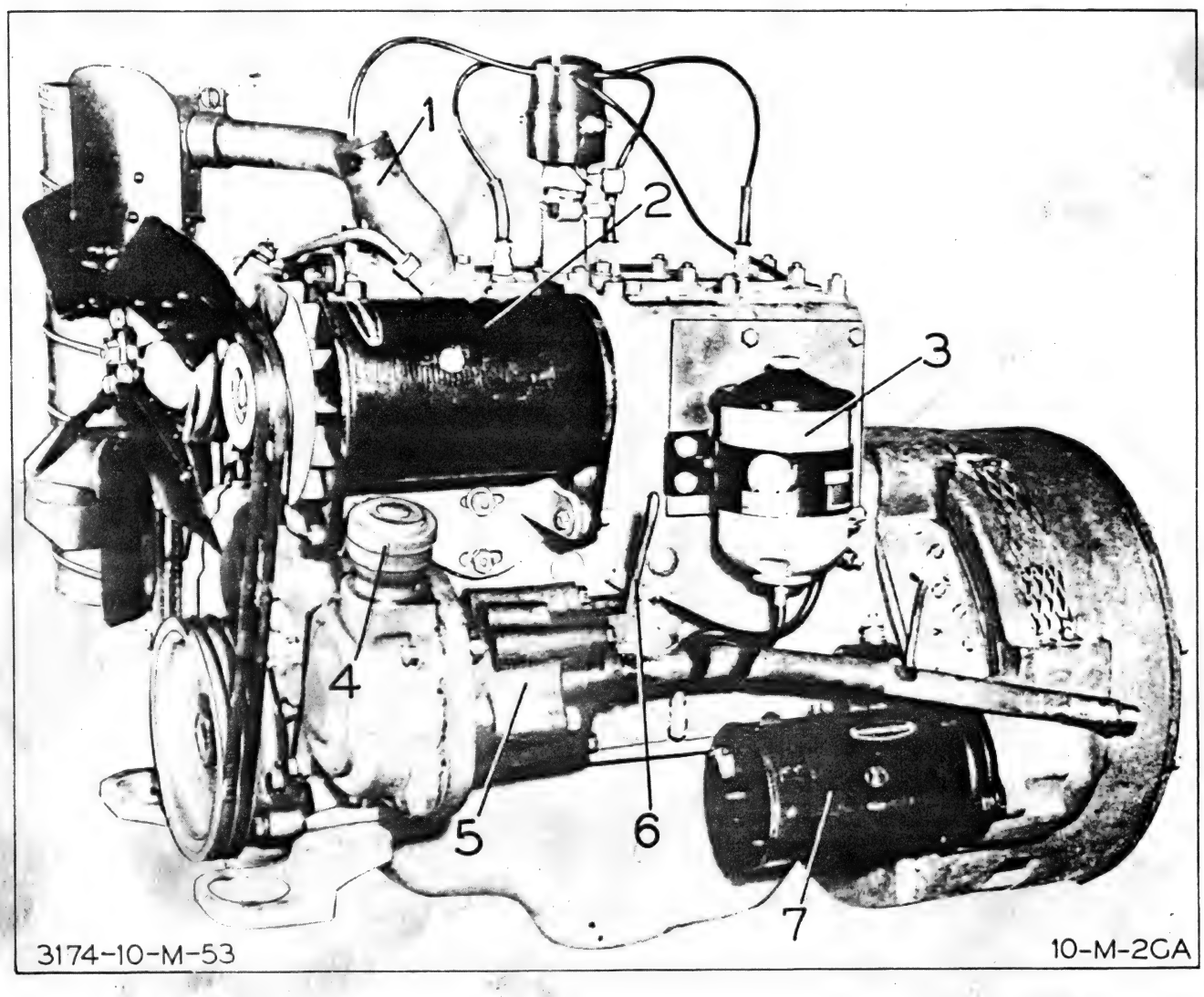
Bare Engine
Horsepower.....51.7 @ 3000 R.P.M.

Oil Capacity.....4 Quarts
Compression
Ratio.....6.7:1



3175-10-M-53 10-M-1GA

1. Exhaust Manifold
2. Intake Manifold
3. Distributor
4. Water Pump
5. Brush Contact Plate
6. Vent Pipe
7. Carburetor
8. Fuel Filter
9. Muffler
10. Fan Blade



1. Outlet Elbow
2. Generator
3. Oil Filter
4. Crankcase Filler Cap
5. Hydraulic Pump
6. Dip Stick
7. Starting Motor

Serial Number
Location.....Above Dip Stick

ENGINE SPECIFICATIONS

PISTON
Cylinder
Diameter.....3.1875 - 3.1895 in.
Pin Hole
Diameter..... .8592 - .8594 in.
Fit in Cylinder
Bore..... .003 in. Feeler
5-10 lb. pull

PISTON RINGS
Grooves 1, 2 and 3
Type Ring.....Compression
Gap Clearance..... .007 - .017 in.
Side Clearance.. .0015 - .0035 in.
Groove 4
Type Ring...Ventilated Oil Control
Gap Clearance..... .008 - .016 in.
Side Clearance.... .001 -.0025 in.

PISTON PIN
Length.....2.676 - 2.691 in.

Diameter..... .8591 - .8593 in.
Fit in Piston..... Light Push
Clearance in Rod. .0002 - .0006 in.

VALVE GUIDE

Length.....2 5/16 in.
Outside
Diameter..... .6565 - .6575 in.
Stem Hole
Diameter..... .3422 - .3432 in.

VALVE STEM CLEARANCE LIMITS

Intake..... .0008 - .0026 in.
Desired .0015 in.
Exhaust..... .0037 - .0055 in.
Desired .0045 in.

INTAKE VALVE

Overall.....5 3/16 in.
Stem Diameter.... .3406 - .3414 in.
Head Diameter.....1 33/64 in.
Seat Angle.....30°
Clearance Limits. .0008 - .0026 in.
Desired .0015 in.

VALVE SPRING
Outside Diameter.....31/32 in.

SPRING LENGTH

Valve Closed.....1 45/64 in.
Valve Open.....1 37/64 in.

SPRING LOAD

Valve Closed.....47 - 53 lbs.
Valve Open.....96 - 104 lbs.

CAMSHAFT
Bearing Journal Diameters
No. 1.....1.8715 - 1.8725 in.
No. 2.....1.7457 - 1.7465 in.
No. 3.....1.2465 - 1.2475 in.
End Play..... .005 - .009 in.

CAM LIFT

Intake..... .2713 in.
Exhaust..... .2801 in.

VALVE TAPPET

Hole Diameter.....1.000 - 1.0005 in.
Tappet Diameter.... .999 - .9995 in.
Clearance Limits
in Block..... .0005 - .0015 in.
Adjustable Clearance .014 in. - hot.

CAMSHAFT BUSHINGS
Inside Diameter
No. 1.....1.8745 - 1.8755 in.
No. 2.....1.7495 - 1.7502 in.
No. 3.....1.2495 - 1.2505 in.
Clearance Limits
No. 1..... .002 - .004 in.
No. 2..... .003 - .0045 in.
No. 3..... .002 - .004 in.

OIL PUMP
Gear Backlash.... .005 - .0065 in.

CONNECTING ROD
Length Between
Centers.....6.998 - 7.002 in.
Bearing Hole
Diameter.....2.0615 - 2.0620 in.
Bearing Thickness .06165 - .0619 in.
Side Play..... .006 - .010 in.
Desired.006 in.

CONNECTING ROD BEARING
Crankshaft Bearing
Size.....1.9365 - 1.9375 in.
Clearance..... .0002 - .0022 in.
Desired .001 in.
Bearing Cap
Torque..... 40 - 45 ft. lbs.

MAIN BEARINGS
Case Hole
Diameter.....2.4365 - 2.4375 in.
Bearing Thickness .0929 - .09315 in.
Crankshaft Bearing Size.....2.249 - 2.250 in.
Clearance.....0002 - .0024 in.
Desired .001 in.
Bearing Cap
Torque..... 100 - 110 ft. lbs.

CRANKSHAFT
End Thrust..... .004 - .006 in.
Thrust On..... Bearing Next to Crank Pulley
Pulley Fit.....1.434 - 1.4345 in.
Gear Fit.....1.435 - 1.4355 in.
Main Bearing
Journal Diameter 2.249 - 2.250 in.
Crank Pin Diameter 1.9365 - 1.9375 in.
Flywheel Flange
Diameter.....4.497 - 4.498 in.
Flange Runout .002 in. Ind. Reading

ENGINE REMOVAL

To remove engine, it is necessary to remove uprights, drive axle and transmission assembly. Refer to respective sections in this manual for procedure.

Pump or drain oil from sump tank.

Shut off gas tank pet cock at gas tank.

Disconnect gas line at pet cock.

Disconnect gas gauge wire.

Remove both hood halves.

Drain radiator at pet cock, located at lower left corner of radiator.

Remove exhaust pipe brass nuts at manifold.

Remove tail pipe clamp at counterweight.

Remove bolts from muffler support at timing gear cover.

Remove muffler assembly.

Remove top and bottom radiator hoses.

Remove counterweight.

1. Fasten chain hoist to rear and top of counterweight.
2. Remove four bolts holding counterweight to frame.
3. Maneuver counterweight away from machine.

Remove four capscrews attaching radiator to frame.

Remove radiator from machine.

Drain oil from engine.

Disconnect all hydraulic lines at valve.

Disconnect choke control at carburetor.

Disconnect hydraulic line union at bottom of hydraulic pump.

Disconnect starter cable from starter, and battery cable at battery and remove battery.

Disconnect and mark following wires:

1. Coil high tension wire.
2. Distributor wire.
3. Three wires at generator.
4. One wire at oil pressure gauge.
5. One wire at block temperature gauge.
6. Wire leads at brush holders at left and right side of flywheel housing.
7. Lead wires at circuit breaker and resistor on back of sump tank.

Disconnect gas throttle linkage at base of sump tank.

Remove bolt at each side of sump tank attaching sump tank to frame. Remove two bolts at rear bottom corner of sump tank at each side of angle plate. Lift sump tank out from frame, tilt slightly forward and remove from machine.

Remove Number Three spark plug and insert a motor hook in spark plug hole. Hook chain fall to motor hook.

Remove bolts from left and right motor support.

Remove engine from machine.

ENGINE INSTALLATION

Attach all accessories to the engine. These include the starter, generator, fan and fan belt, carburetor, gasoline filter, distributor and all spark plugs except Number Three plug. Insert motor hook in this spark plug hole.

Attach chain fall to motor hook and raise engine into position over machine. Lower slowly until engine rests on motor supports, and flywheel housing rests on blocking that was put in place before removing drive axle and transmission assembly.

Install bolts at right and left motor support.

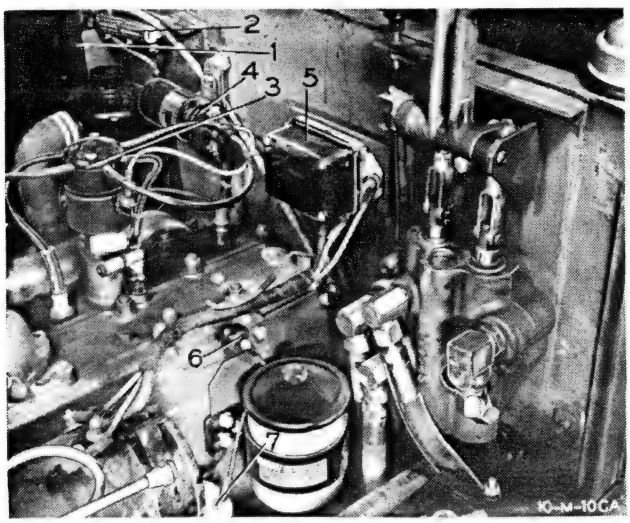


Fig. 79

Install sump tank with attached assemblies. These include air cleaner, circuit breaker, resistor, ignition coil, voltage regulator, choke control, and hydraulic valve and levers.

Connect hydraulic lines at valve and pump.

Connect gas throttle linkage at left base of sump tank.

Connect wires at brush holders on flywheel housing, circuit breaker, resistor, block temperature gauge, oil pressure gauge, generator, distributor, and ignition coil.

Replace battery and cables, and connect cable at starter.

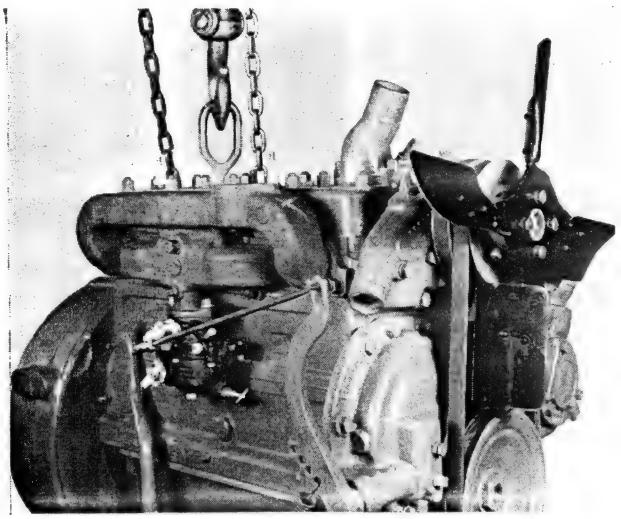


Fig. 80

Connect choke control at carburetor.

Replace oil in engine to proper level.

Replace radiator and radiator hoses. Refill radiator and cooling system with proper coolant.

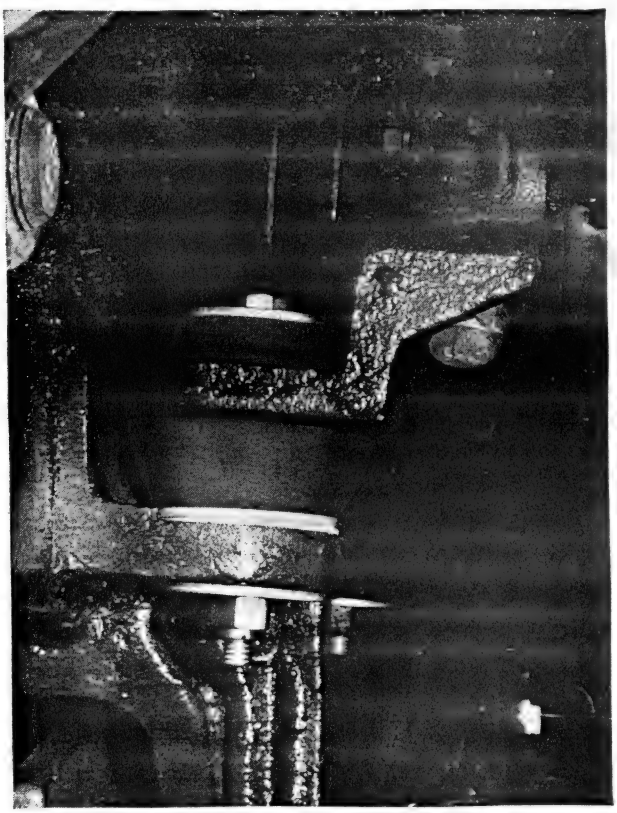


Fig. 81

Refill sump tank to proper level.

Remove motor hook and install spark plug.

Replace muffler assembly and governor spring tension bracket bolts.

Replace drive axle and transmission, uprights and counterweight.

Replace both halves of hood and connect gas line and gas gauge wire.

Check timing of engine. Refer to Electrical System for procedure.

TUNE-UP

MINOR TUNE-UP

(1) **Spark Plug Adjustment.** Remove and clean spark plugs.

Fig. 82 — Spark Plug Adjustment

(2) **Distributor Point Adjustment.** Remove distributor cap and examine condition of breaker points. Points must be clean, smooth, and make full contact. If points are pitted or not smooth, file or hone them until they are smooth. Clean points with dry-cleaning solvent. Adjust points for full contact, then adjust gap of points.

(3) **Check Battery and Ignition Wiring.** Examine all ignition wires, ignition coil high-tension wires, and ignition coil to distributor wires for corrosion at terminals and broken or cracked insulation. Press ignition wires firmly into distributor cap and onto spark plugs; tighten ignition coil to distributor wires and ignition coil high-tension wire.

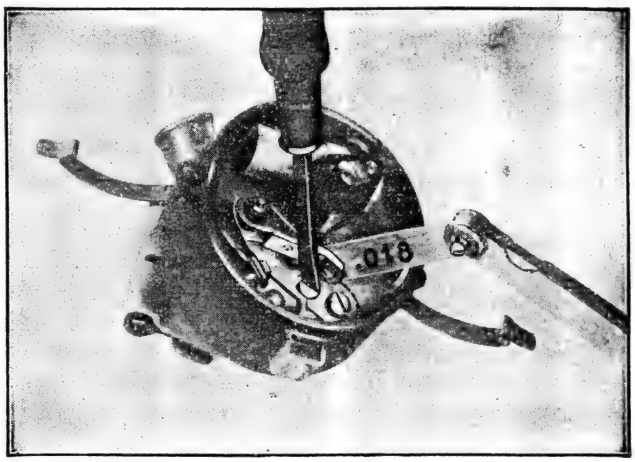


Fig. 83 — Distributor Point Adjustment

IGNITION WIRING

Description. The wires for the spark plugs are high tension No. 14 with insulation, measuring 7 MM O.D. A snap-on terminal is fitted at spark plug end and no terminal is required at distributor end due to design of distributor cap and cover. The wires are short, nine inches for front and rear cylinders and six inches for center two, and due to shortness of run do not require any other insulation or closure.

Inspection. Before removing any ignition wire, test each wire by holding the spark plug end of the wire being tested a short distance from the metal base of plug. If, with engine running, a good spark may be observed jumping across from terminal to plug base, the wire may be considered o.k. Inspect insulation and make sure there are no bare places. Replace any wire with damaged insulation. Remove distributor cap cover and make sure good connection is made at this point. Replace any wire which fails to deliver a strong spark.

Replacing Ignition Wire. With defective wire removed it has been necessary in order to remove distributor end of wire to take off distributor cap cover. The cover is held in place by two flat head screws. In the center of each molded groove in the top of distributor cap is a sharp metal projection extending up from the various metal inserts inside of distributor cap to which the rotor delivers the high tension load at timed intervals. These sharp projections pierce the insulation of the spark plug wires and contact the wire center. In installing new wires it is only necessary to press the wire down onto this sharp projection

firmly until wire seats in groove. When top cover is put on and screws are tightened this contact is maintained. The grooves for spark plug wires are numbered and the one for the coil wire is so designated. With wire secure in distributor cap press metal terminal over end of spark plug. As this is a press-on fit it may be necessary to close terminal slightly with pliers to make sure of tight contact with plug. Check coil wire at this time also.

ENGINE DISASSEMBLY

Remove Sub-Assemblies. Place engine on stand, and remove the generator, carburetor, distributor, hydraulic pump, fan belt, generator belt, water pump, spark plugs, ignition wires and starting motor.

Remove Cylinder Head and Fan. Remove cylinder head stud nuts and washers. Pull cylinder head from block. Remove cylinder head studs with stud remover.

Remove Oil Pan. Drain oil by removing drain plug at bottom of pan. Place engine upside down. Remove oil pan cap screws and lift off oil pan and gaskets.

Remove Pistons and Connecting Rods. Remove connecting rod bolt cotter pins, nuts and bearing caps. Tape bolts to protect crankshaft and cylinder walls. Lay engine on side and push pistons and connecting rods out through top of cylinders. Bearing caps must be re-installed on rods from which they were removed.

Remove Oil Pump. Remove nut and washer. Pull out oil pump.

Remove Intake and Exhaust Manifold. Remove stud nuts and lockwashers holding manifold assembly to block. Remove manifold assembly and gasket.

Remove Valves, Guides, and Springs. Remove the valve cover plate and gasket. Remove the valve spring retainer locks after compressing the valve springs with a valve spring compressor and then lift out valves. Remove the valve springs and retainers by compressing the springs and pulling them out over the valve tappets.

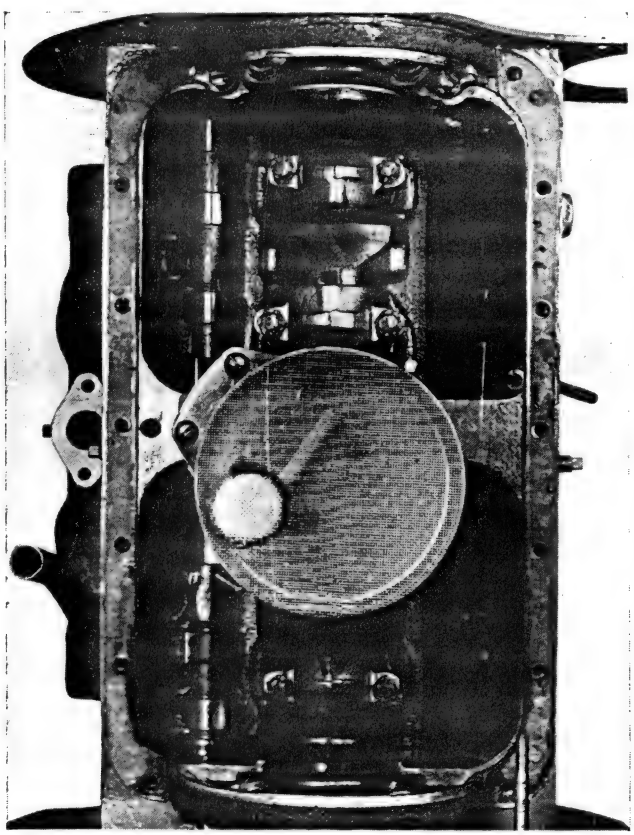


Fig. 84 — Bottom View of Engine With Oil Pan Removal

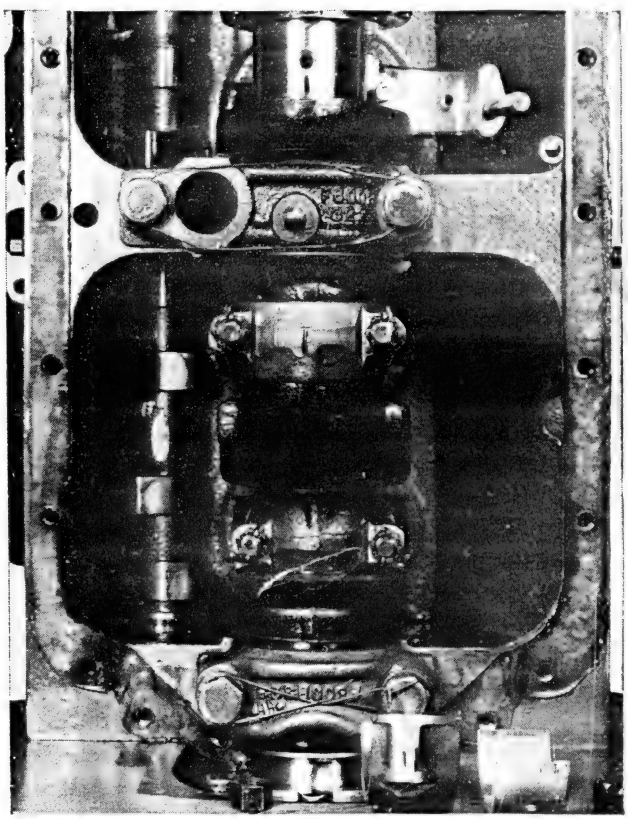


Fig. 85 — Bottom View of Engine Showing One Connecting Rod and Oil Pump Removal

Remove Timing Gears. Remove crankshaft starting jaw or nut and pull off fan drive pulley. Remove cap screws, bolts, and nuts around timing gear cover and remove cover, being careful not to damage oil seals. Remove idler gear. Remove governor plate on cam shaft gear; remove nut on end of camshaft, and remove camshaft gear. Using a puller remove crankshaft gear.

Remove Front End Plate. Remove the three cap screws and the two counter sunk cap screws from front of plate. Lift off end plate.

Remove Flywheel and Flywheel Housing. Remove brush holder assemblies from both sides of flywheel housing. Remove six nuts from flywheel to crankshaft studs. Pull flywheel off studs and out of housing.

Remove five bolts and washers holding flywheel housing to block and remove housing.

Remove Crankshaft. Cut lock wires and then remove crankshaft bearing cap screws and lock-washers. Lift off bearing caps, bearings, and remove crankshaft.

Remove Camshaft and Valve Lifters. Remove cap screws from end thrust plate and pull out camshaft. Remove all lifters.

Remove Camshaft Bushings. All camshaft bushings are removable, but seldom if ever have to be replaced. If necessary to replace bushings remove buhing locking pins and bushings.

Cleaning, Inspection and Repair of Component Parts. Use scraper to remove carbon from cylinder head, valves and guides. Wash all parts thoroughly in solvent, dry-cleaning, using a stiff brush. Dry with clean cloths. Clean all oil and

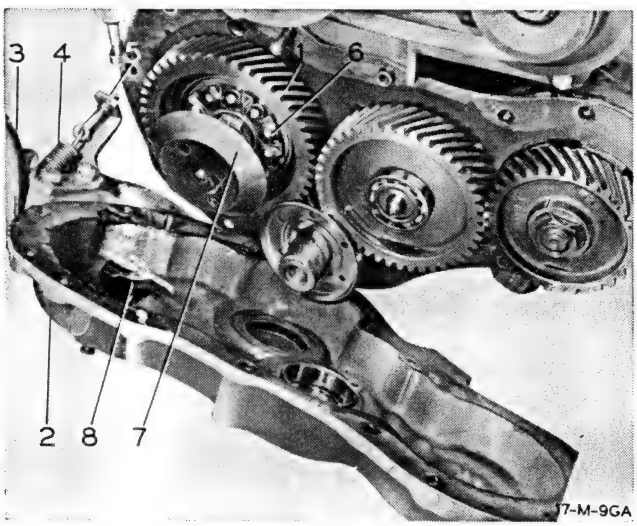


Fig. 86 — Timing Gears, Timing Gear Cover, Crankshaft Pulley

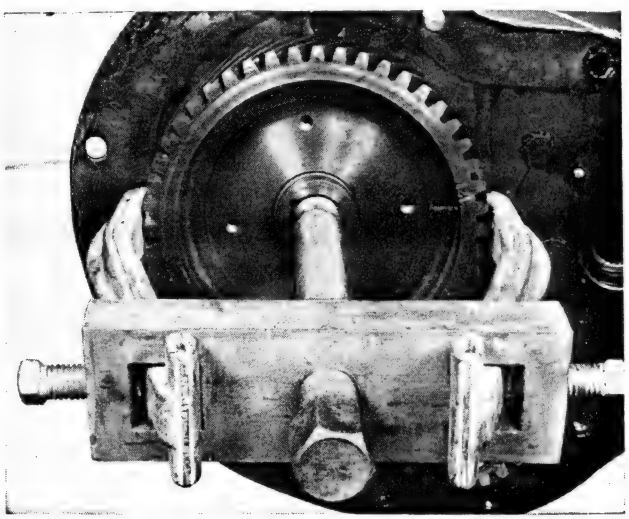


Fig. 88 — Removing Cam Shaft Gear

water passages with steam or compressed air. Remove carbon from upper ends of cylinder walls. Use compressed air at water inlet manifold opening to remove loose scale. Immerse block in tank of solvent, dry-cleaning, for several minutes. Remove block and dry thoroughly with compressed air, and wipe cylinder walls with clean cloth. In-

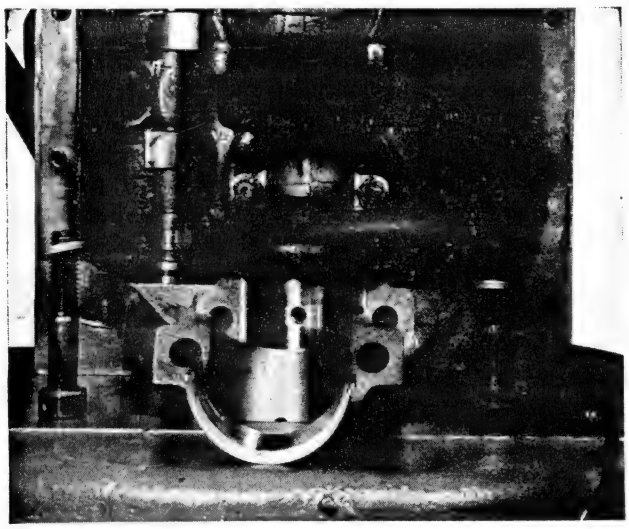


Fig. 89 — Main Bearing Removal

spect all parts for wear or damage and replace if necesssary. Inspect compression pressure of valve springs. Inspect tappet guides for wear. Inspect crankshaft. Inspect all bearings. Inspect cylinder walls, pistons, rings, timing gears, camshaft and crankshaft for concentricity.

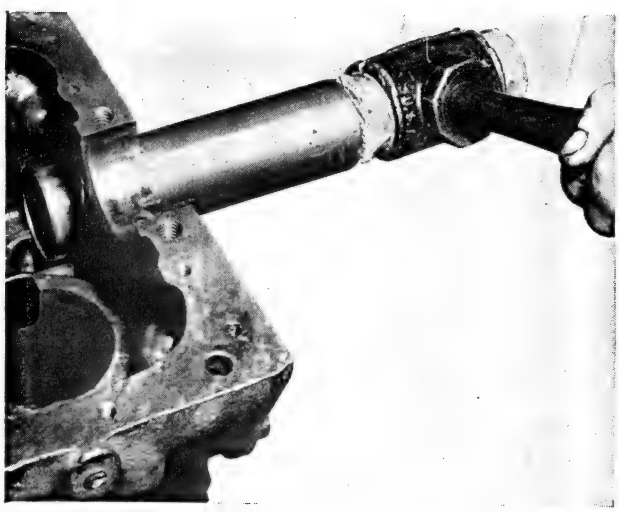


Fig. 90 — Removing Cam Shaft Bushing

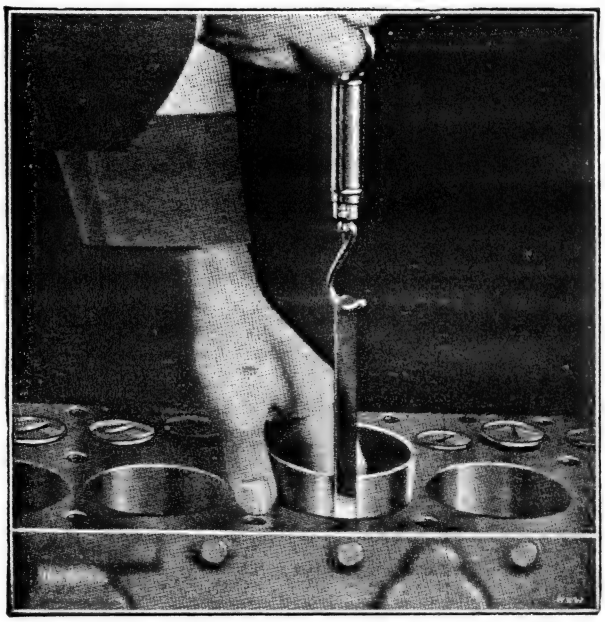


Fig. 91 — Piston Clearance

ENGINE REASSEMBLY

1. Install valve lifters. Insert camshaft in block. Fit pistons with a clearance of .002 inch and piston rings with a ring gap of from .009 to

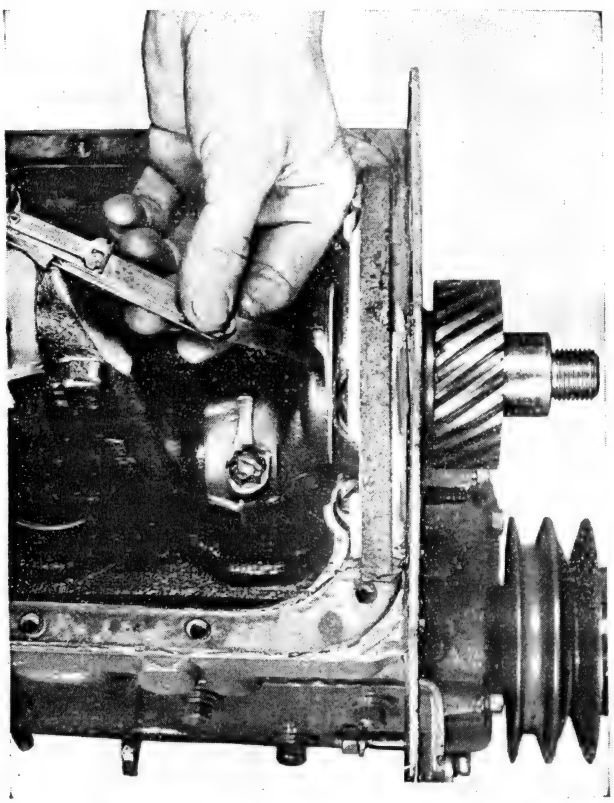


Fig. 92 — Checking Crankshaft End Play

.014 inch. Pins should be fitted with a —.0003 inch tolerance fit in piston pin bushings and a +.0003 press fit in piston boss.

2. Install new main bearings if engine has had considerable service. Make sure there is no foreign matter between shell and case boss or bearing cap. When assembled these bearings should have .0015 to .002 clearance.

Allow .004 to .006 inch end thrust to crankshaft (by adding or removing shims back of crankshaft gear.)

3. Install oil pump, end plate, filler blocks, corks, oil pan, timing gears and timing gear cover. Install valve guides, valves, valve springs, retainers and locks. Adjust intake and exhaust valves to .012 inch clearance (Cold). Install all valve chamber cover and cylinder head.

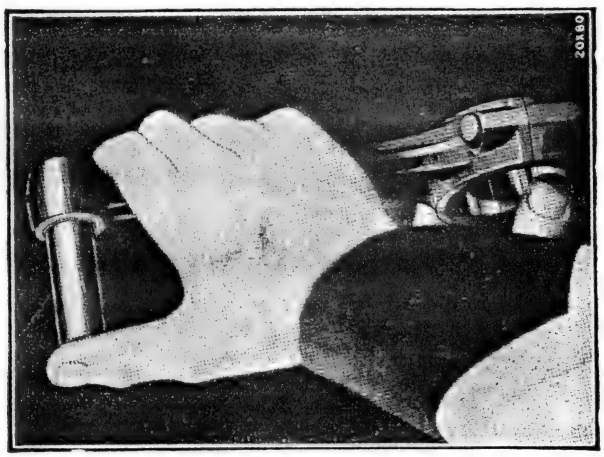


Fig. 93 — Fitting Wrist Pin

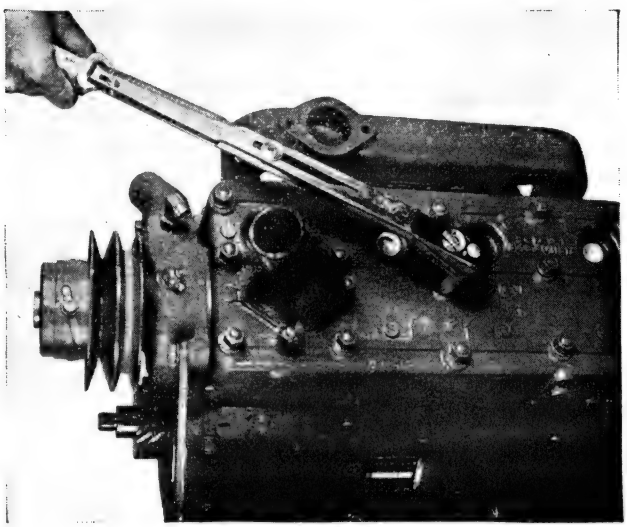


Fig. 94 — Checking Torque on Cylinder Head Nuts

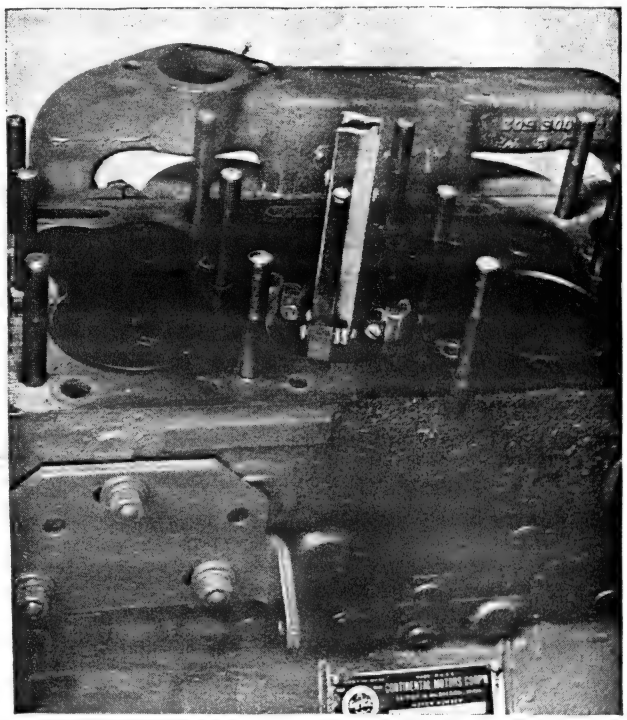


Fig. 95 — Honing Cylinder

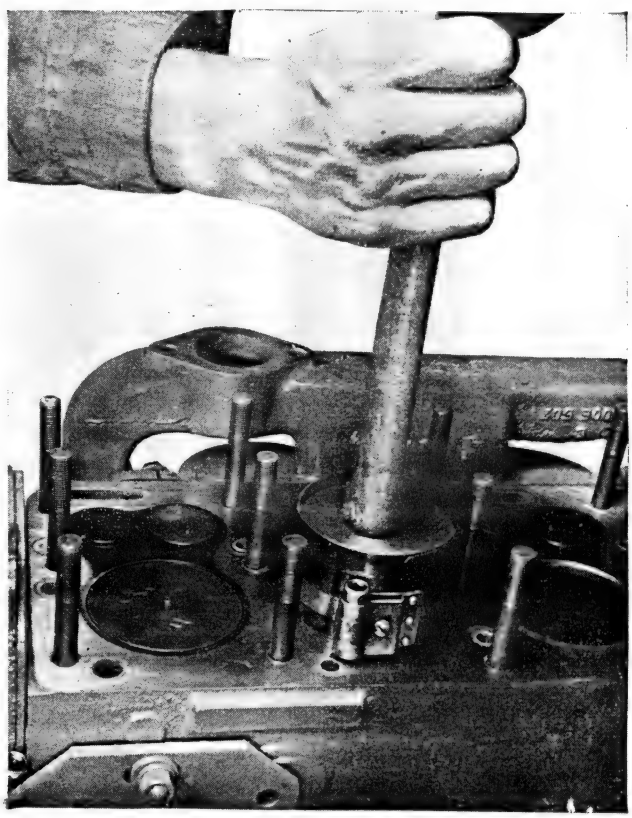


Fig. 96 — Installing Piston

In installing cylinder head tighten nuts to 30, 35 foot pounds using tension wrench (Fig. 94).

Install intake and exhaust manifold and fan assembly. Install carburetor, spark plugs, flywheel housing, and flywheel. Install brush holder assemblies on flywheel housing. Install water pump and generator belts, distributor and ignition wires.

If new rings are to be installed remove glaze from cylinder walls with a cylinder hone (Fig. 95).

To install pistons in cylinder bore use a ring compressor as in Fig. 96.

GRINDING THE VALVES

Drain the radiator and cooling system.

Disconnect gas line from gas tank pet cock at right side under hood, disconnect gas tank to gauge wire.

Remove both halves of hood.

Remove air cleaner tube to carburetor, disconnect accelerator linkage to the carburetor, disconnect gas line at gas filter.

Remove carburetor and gas filter from manifold by removing two carburetor stud nuts, remove valve cover and gasket, remove exhaust manifold and gasket.

Remove top radiator hose.

Remove distributor, spark plugs, loosen cylinder head nuts and remove same from block studs.

Remove oil filter bracket from head.

Remove cylinder head end of water pump bypass, and remove cylinder head from motor block, removing distributor drive shaft from cylinder head.

Remove cylinder head gasket from the motor block. At this point the motor is ready to have the valves ground and the valves, tappets, valve springs are accessible for this operation.

Use a valve lifter to compress valve spring, with long nose pliers.

Remove valve keeper pin and valves can be removed one at a time in this way, be sure valve is closed before attempting to compress spring. Place valves in rack ready for grinding.

Remove carbon from heads of pistons, block and cylinder head, remove all traces of rust and carbon

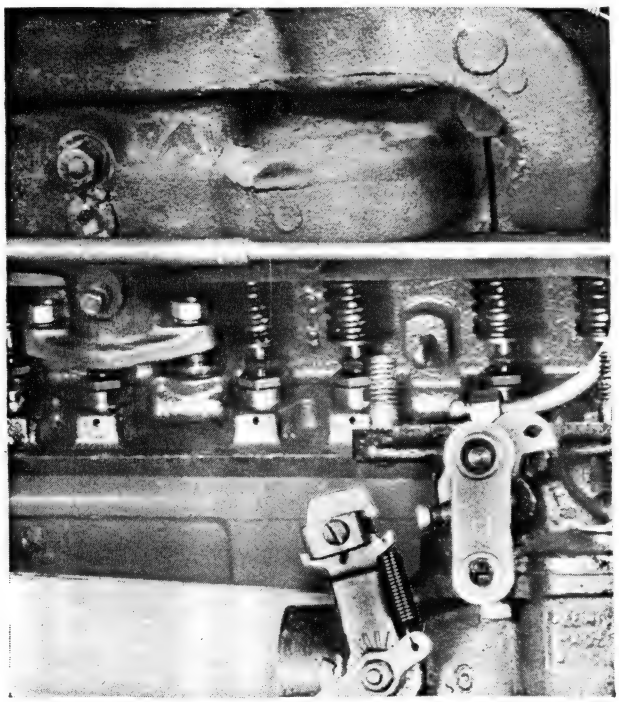


Fig. 97 — Valve Chamber

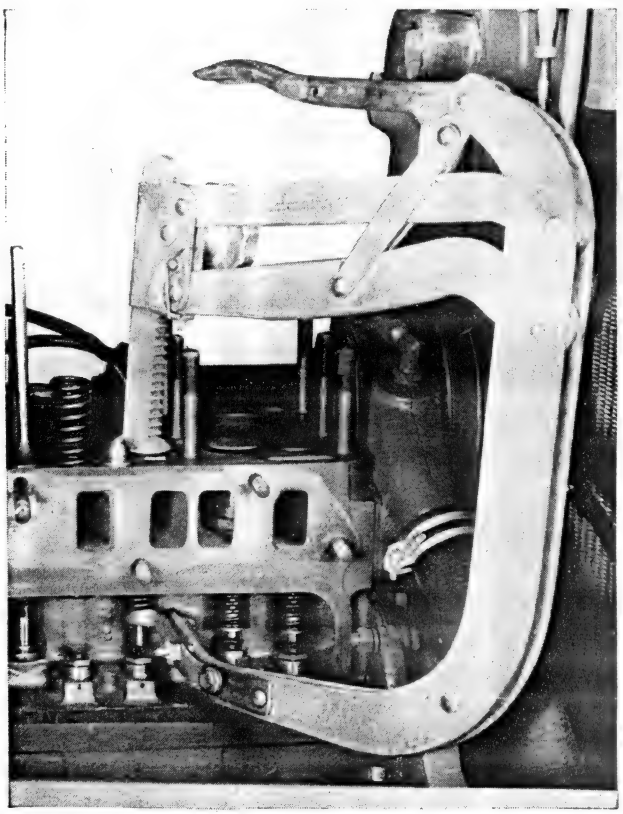


Fig. 98 — Removing Valve Keepers

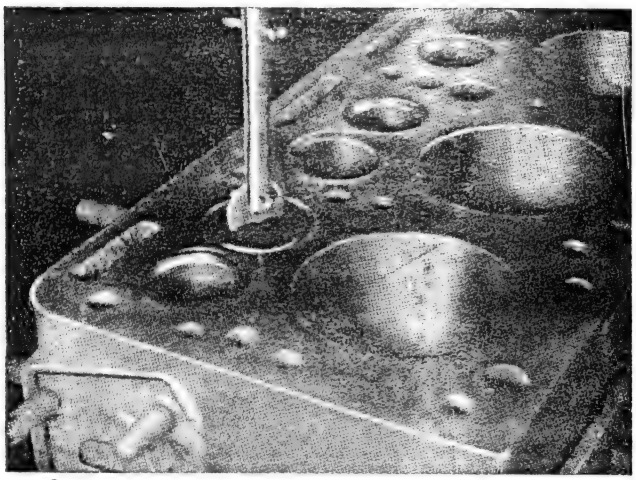


Fig. 99 — Grinding Valves

at manifold. Always replace new head gasket, manifold gasket and carburetor to manifold gasket, it is advisable to replace new spark plugs and set the gap at .025 with a feeler gauge. It is further suggested to install new condenser and points for distributor at this time.

Replace the valves and keepers.

With a .012 inch feeler gauge measure the gap between valve lifters and bottom of valve stem.

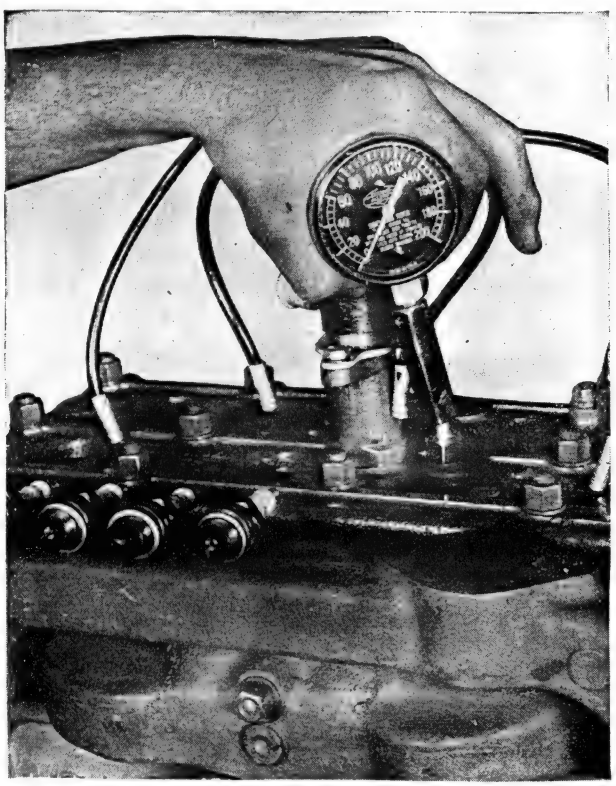


Fig. 100 — Checking Compression

Adjust intake and exhaust valves to .012 inch clearance cold. Adjust remaining valves according to firing order 1-3-4-2, which is also embossed on the cylinder head.

Install gasket and head.

Check for cracks in block and water and compression leaks. Tighten cylinder head with torque wrench from 30 to 35 foot pounds.

ENGINE MAJOR TUNE-UP

Compression Gauge Test. Start engine and allow it to warm up to normal operating temperature. Stop engine and remove all spark plugs. Open carburetor throttle. Insert compression gauge in a spark plug hole and hold gauge tightly in hole. Crank engine with starting motor until gauge reaches its highest reading. Record reading. Repeat procedure on balance of cylinders. Minimum reading should not be lower than eighty-five pounds with maximum allowable variation of ten pounds.

NOTE: Low readings indicate sticking valves, burned valves seats or worn piston rings. To determine whether or not valves or piston rings are the cause of the low readings, check tappets clearance and repeat compression gauge test. If compression reading is still low, and engine does not smoke excessively, valves are at fault. These should be ground, seated or replaced.

Battery Capacity Test. Take hydrometer gravity reading of battery. Connect a voltmeter positive lead wire to battery positive terminal and then connect voltmeter negative lead wire to battery negative terminal. Turn off all switches and voltmeter reading should be six to eight volts (without any draw of current from battery). If hydrometer gravity reading or voltmeter reading is low, then recharge battery.

Battery Cable and Cable Connections Test. Connect voltmeter positive-lead wire to battery positive terminal and voltmeter negative-lead wire to a ground on engine. Crank engine by pressing starter button and at same time record voltmeter reading, which should be not more than .1 volt. If reading is higher, then tighten battery positive cable connection at battery terminal, also starting switch cable at battery terminal. If engine is cranked very slowly when starter button is pressed, it indicates a faulty starting switch or starter. Replace switch or overhaul starter.

Air Cleaner Check. Remove air cleaner body and cup, clean thoroughly and refill with new oil, to proper level.

VALVE COVER AND GASKET

Description. The valve cover is attached to engine cylinder block under manifold assembly by two screws. It covers the valve tappet chamber in order to prevent dirt from getting into the mechanism, and also to prevent lubricant from being splashed out of the block.

VALVE LIFTERS ADJUSTMENT

The valve lifters should be adjusted with engine cold. The valve lifter screws on some of the older engines are of the self-locking type. Later models have an adjustable screw and lock nut.

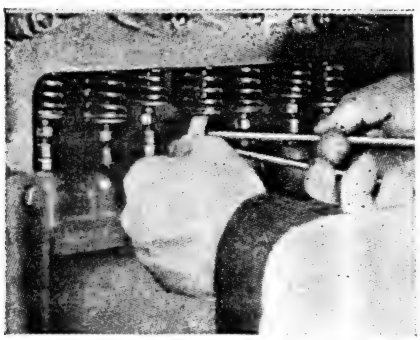


Fig. 101—Adjusting Valves

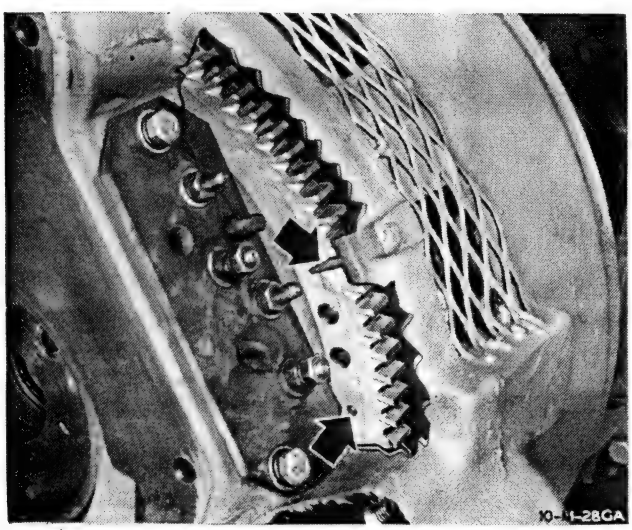


Fig. 102

Adjustment With Engine Cold. Remove number one spark plug (nearest radiator) and press thumb over number one spark plug hole, turn engine over slowly until you feel air "whooshing" up against and around your thumb. Stop turning engine over at this point as the number one piston is on the compression stroke. It is nearing top dead center. Resume turning engine over very slowly. When top dead center marking on flywheel appears center this marking with the pointer. Number one piston is on top dead center and in position for firing with both intake and exhaust valves closed.

With a .012 in. feeler gauge measure gap between valve lifters and bottom of valve stem. Adjust intake and exhaust valves to .012 in. clearance. Adjust remaining valves according to firing order, 1, 3, 4, 2.

OIL FILTER

Description. The oil filter is of the replaceable element type and is mounted on the side of the frame. It is connected to engine by means of metal and flexible tubing. Oil is pumped out of the engine by the oil pump through the filter and back into the engine crankcase.

Maintenance. Remove oil filter cover screw, cover, gasket, retaining spring. Lift out filter element. Remove drain plug at bottom of filter and drain off sediment. Clean inside of filter with dry cleaning solvent. Replace drain plug and install new gasket over stud. Insert new filter element. Install top gasket over stud. Replace retainer spring, new cover gasket, cover and cover screw while holding cover down against retainer spring.

MECHANICAL GOVERNOR

The purpose of the governor is to limit the top speed of the engine to a desired R.P.M. The governor is located on the camshaft gear behind the timing gear cover. It consists of a ball bearing assembly engaged to the governor cup and shaft assembly which sets on the governor arm. The function of the governor is based on action of two forces working against each other. One is the centrifugal force exerted on the ball bearing assembly when engine is running, tending to close the throttle; the other force consists of two adjustable springs, one located inside the timing gear cover, and the other attached to the external part of the governor arm. Both tend to open the throttle by counteracting the pressure of the cup against the governor arm. To set governor properly it is nec-

essary to use an electric tachometer that will register the required 1800 R.P.M. Usually these will register 0 to 4000 R.P.M., and are adaptable to 4-6 or 8 cylinder engines.

The location of the governor is on the camshaft gear (1) Fig. 102A, inside the timing gear cover (2). There is an external lever (3) mounted to the timing gear cover which is connected by linkage to the throttle and carburetor controls. A spring (4) is also connected to the governor lever, the other end of which is mounted solidly to the bracket (5). The purpose of this being to control the tension of the lever.

The governor consists of a fly ball assembly (6) which is attached to the camshaft gear (1). The fly ball assembly is engaged to the governor cup shaft assembly (7) which acts against the governor arm (8).

GOVERNOR REMOVAL

Remove counterweight and radiator. (Refer to their respective sections for removal.)

Loosen lock bolt at generator adjusting arm, slide generator toward engine and remove dual belts. Remove cotter pin and pull pin out of carburetor rod yoke to governor arm. Remove governor speed control bolt and nut and speed control spring.

Loosen motor mount bolts and with a chain fall raise engine three to four inches from its mount.

Remove crankshaft attaching nut and with a gear puller remove crankshaft pulley. Remove all retaining cap screws securing gear cover to block and remove gear cover. Pull off the cup and shaft assembly. Turn off the camshaft end nut, and remove fly ball assembly.

GOVERNOR INSTALLATION

When all worn or damaged parts have been replaced install fly ball assembly and secure with locking nut. Place the cup and shaft assembly into position. Fit the gear cover to block and secure with cap screws. Install the crankshaft pulley and secure with attaching nut.

Connect speed control spring and make proper R.P.M. adjustment on the nut. Connect carburetor rod to governor arm.

Slowly lower motor to its mount and secure with bolts and nuts. There should be a slight "squash" to the rubber mounts. Install the dual belts and make proper adjustment of belts on generator adjusting arm. Install radiator and counterweight.

GOVERNOR ADJUSTMENT:

1. Connect Tachometer to engine, start engine and warm up to normal temperature.
2. To decrease engine speed loosen speed control nut, which decreases tension on spring. To increase speed tighten speed control nut.
3. Recommended governor setting 1800 R.P.M.
4. If engine should surge or not maintain steady top speed then adjustment for the surge can be made at governor spring bumper screw in the gear cover by loosening lock nut and turning bumper screw to the right until surging ceases and engine runs steady at top speed. Tighten lock nut securely after adjustment. It may be necessary to readjust top speed after making surge adjustment.

ENGINE TROUBLE SHOOTING GUIDE

A good rule to follow in locating engine trouble is to never make more than one adjustment at a time. Stop and think how the motor operates, and figure out the probable cause of any irregular operation. Then locate the trouble by a process of elimination. Remember that the cause usually is a simple one, rather than a mysterious and complicated one. The following outline will be helpful in locating ordinary engine troubles:

STARTER WILL NOT OPERATE

1. Discharged or low battery:

Make sure that storage battery is filled with water at least three-eighths inch above the plates and fully charged. Proper fluid gravity is 1.275. Low battery will result in slow cranking speed and weak spark.

2. Loose or corroded battery terminals:

Check cable connections at the terminal posts. Break the connection, clean and reclamp.

3. Defective starter switch:

First inspect the connections. Try the starting button. If the engine still fails to start, then refer to the starting motor section for more detailed instructions.

4. Bendix pinion of starting motor jammed:
Loosen the starter and see if the starting pinion is "free."
5. Defective starting motor:
Inspect commutator and brushes.
6. Engine itself may be "frozen":
With ignition off, crank engine by hand, to make sure it is "free."

STARTING MOTOR TURNS BUT ENGINE DOES NOT

1. Weak Battery:
Not sufficient power to turn motor at normal speed. Starter gear will not engage when this condition exists, the starting motor will have a characteristic hum.
2. Acid-eaten cable:
Insufficient current getting through. Give particular attention to ground connection on battery.
3. Broken Bendix Drive, or gum on Bendix Spiral:
Remove the starting motor and look for broken parts. If Bendix pinion does not move freely on spiral, wash pinion and spiral in solvent and lubricate sparingly with light engine oil, SAE 10.
4. Stripped gear on flywheel:
This is extremely rare.

STARTER TURNS ENGINE AT NORMAL SPEED BUT ENGINE WILL NOT START

(This also covers hard starting and slow starting. Possible causes will be covered under (A) Improper Carburetion, (B) Electrical Difficulties, (C) Poor Compression, (D) Wrong Timing.)

A. IMPROPER CARBURETION

1. Out of fuel: tank is empty.
2. Gasoline not reaching fuel pump. See if sediment bowl on fuel pump is filled with gasoline. If it is not, and if there is fuel in tank, the line may be clogged. Disconnect line at fuel pump and blow through line. Look for dents in tubing, and air leaks in fuel pump gaskets or in fuel line connections. Make sure that vent to gasoline tank is open.
3. Fuel not reaching the carburetor. First remove sediment bowl from fuel pump and see if screen is clean. Then disconnect line from fuel pump to carburetor and see if gasoline flows out freely. This line may be clogged with dirt.
4. Fuel not reaching the cylinders. The choke may not be closing tightly. The carburetor may be out of adjustment, float level too low, or the jets may be clogged with dirt or gum.
5. Engine flooded. If the spark plugs are wet, this indicates flooding, caused by using the choke too long.
6. Air leaks at intake manifold or governor gaskets.
7. Poor grade, oil or stale fuel in combination with cold weather.

B. ELECTRICAL DIFFICULTIES

Follow the trouble-locating procedure outlined under "Electrical System." Possible troubles may be summarized as follows:

1. Primary Circuit
Corroded, dirty or loose connections.
Weak, leaky or grounded condenser.
Distributor points pitted or fused.
Distributor points set to wrong gap.
Breaker arm sticking.
Hinge bushing tight on pin.
1. Secondary Circuit
Corroded, dirty or loose connections.
Pay particular attention to high tension wire from coil to distributor, and all wires in distributor cap.
Wet wires.
Moisture or carbon on spark plug.
Cracked insulation, leaks and shorts.
Cracked distributor cap.
Carbon contact inside distributor cap broken or missing.
Rotor contact spring broken.
Ignition coil spring broken.
Improper gap on spark plugs.
Fouled or cracked spark plugs.
Distributor wired to wrong plugs.

C. POOR COMPRESSION

A rough-and-ready check for compression is to remove spark plug and place your thumb over the spark plug hole, then crank the engine. Accurate method is to use a compression gauge. Do not expect all cylinders to show the same compression pressure, but a decided difference will indicate improperly seating valves, worn rings, worn cylinder, or leaky gasket. After taking an initial reading, seal the piston with a teaspoonful of engine oil poured through spark plug hole, and take a second reading: If pressure does not increase this will indicate that improperly seating valves are at fault. Poor compression may be caused by any of the following:

1. Loose head.
2. Damaged cylinder head gasket.
3. Poorly seating valves.
4. Broken valve springs.
5. Valves holding open due to insufficient clearance.
6. Valves sticking open due to carbon and gum on stems or in guides.
7. Badly worn, broken or stuck piston rings.
8. Cylinder scored.

D. **WRONG TIMING**

Remove number one spark plug, put your thumb over the spark plug hole and test for compression stroke, cranking the engine over by hand. Then set piston on top dead center of the compression stroke. TDC mark on flywheel will line up with pointer in bell housing, the breaker points in distributor should be just starting to open. To retime distributor and to check wires to spark plugs, follow the procedure under ignition timing.

LACK OF POWER

1. Faulty compression.
2. Incorrect timing.
3. Poor carburetion.
4. Restriction in air supply to carburetor caused by dirt in screen or choke valve not completely opening.
5. Throttle control linked up so that throttle valve is not fully opening.
6. Dirt in sediment bowl of fuel pump.
7. Dirt in fuel lines or carburetor jets.
8. Air leak in fuel pump or fuel line.
9. Air leak in manifold gasket or at governor gaskets.
10. High engine temperature, caused by worn water pump or clogged water jackets.
11. Vent of gasoline tank not open.
12. Pre-ignition, caused by carbon deposits.
13. Engine and propeller shaft misalignment.

ROUGH, UNEVEN IDLING

1. Improper adjustment of carburetor idling jet air passage clogged.
2. Air leaks in intake manifold or carburetor—Loose manifold nuts. Damaged gasket at manifold or governor.
3. Faulty ignition.
4. Weak ignition coil.
5. Spark plug difficulties.
6. Uneven compression.
7. Water leak at cylinder head gasket or manifold.

MISSING AT HIGH SPEED

1. Spark plug troubles.
2. Broken insulation on high-tension wires.
3. Faulty breaker-points.
4. Fuel obstruction, indicated by back-firing.
5. Incorrect tappet clearance.

MISSING AT ALL SPEEDS

1. Blown head gasket.
2. Sticking valves, broken valve spring.
3. Fouled spark plugs, broken insulation.
4. "Leaky" high tension wiring.
5. Pitted or fused breaker points.
6. Incorrect valve tappet clearance.
7. Incorrect breaker-point gap.
8. Punctured condenser.
9. Gasket leak at intake manifold or governor.

CRANKSHAFT KNOCKS

These are usually detected as dull, heavy, metallic knocks which increase in frequency as the speed and load on the engine is increased. The most common crankshaft knock is that caused by excessive clearance at one or more main bearings. This is most audible when engine is pulling hard, on acceleration, or when engine is cold. By alternately shorting out each spark plug, the approximate location of the loose bearing can usually be determined. Excessive crankshaft end play causes a sharper noise or rap which occurs at irregular intervals. In bad cases this can generally be detected by releasing and engaging the clutch. Causes of crankshaft knocks include the following:

1. Excessive bearing clearance.
2. Excessive end play.
3. Eccentric or out-of-round journals.
4. Sprung crankshaft.
5. Insufficient oil supply.
6. Low oil pressure.
7. Badly diluted oil.
8. Loose flywheel.

CONNECTING ROD NOISES

Connecting rod noises are usually a light pound or knock of much less intensity than main bearing knocks. The noise is usually evident with the engine idling and becomes louder when engine speed is slightly increased. Connecting rod noise can best be located by shorting out one spark plug at a time. These noises should not be confused with piston or piston pin noises. Possible causes are as follows:

1. Excessive bearing clearance on crank pin.

2. Insufficient oil supply.
3. Low oil pressure.
4. Badly diluted oil.
5. Misaligned connecting rods.
6. Out-of-round or tapered crank pin journal.

PISTON NOISES

The most common piston noise is "slap" due to the piston rocking from side to side in the cylinder. Piston-slap usually causes a hollow, muffled bell-like sound, or a click. Slight piston noises that occur with a cold engine and disappear after the engine is warm, do not warrant replacement. Piston-slap is most audible when driving the engine at low speed under load.

Piston and ring noises can be located by putting a spoonful of heavy engine oil (SAE 50) into the suspected cylinder through the spark plug hole. Crank the engine over by hand for several revolutions with the ignition off, until the oil has worked down past the piston rings. Replace the spark plug, start the engine and determine if the noise still exists.

PISTON PIN NOISES

The most common piston pin noise is the result of excessive piston pin clearance. This is characterized by a sharp, metallic double knock, generally audible with the engine idling. Possible causes:

1. Excessive piston pin clearance in piston boss.
2. Excessive piston pin clearance in bushing.
3. Bushing loose in connecting rod.

VALVE AND TAPPET NOISES

Noisy valve action has a characteristic clicking noise occuring usually at regular intervals. The frequency of valve action noise is generally less than other engine noises, because the valves are operated by the camshaft running at one-half of crankshaft speed. If one or two of the valves or tappets are causing the noise, the clicking sound will be intermittent, but if the condition exists with a majority of the valves, the noise may be continuous.

The common cause of valve action noise is that of excessive clearance between tappet and valve stem. Correct setting for this engine is .014. Do not set for less than .014 because this is liable to cause burned valves. Possible causes of valve and tappet noises:

1. Excessive tappet clearance.
2. Threads stripped on adjusting screw.
3. Broken valve springs.
4 Excessive valve stem to guide clearance.

SPARK KNOCK AND FUEL KNOCK

Included under this heading are Pre-ignition and Detonation. Pre-ignition is caused by an incandescent particle of carbon or metal in the combustion chamber, which fires the mixture prematurely, while the piston is still rising. Detonation is caused by fuel of wrong octane rating which burns too rapidly, throwing a sudden and abnormally high pressure against the down-moving piston. The two have a similar sound, a metallic ringing knock which is often described as a "ping." This is usually heard when the engine is laboring, accelerating rapidly, or overheated.

Causes:

1. Carbon deposits in combustion chamber.
2. Ignition timed too early.
3. Faulty spark plugs.
4. Carbon on spark plugs or burned porcelains.
5. Hot valves resulting from:
   Insufficient tappet clearance.
   Improper seating.
6. Excessive engine temperature, caused by faulty water circulation.
7. Low octane fuel.
8. Old or stale fuel.
9. Extremely lean carburetor mixture.

VIBRATION ORIGINATING AT ENGINE

The most common sources of vibration originating in or on the engine, as distinguished from causes originating outside the engine (covered below) are as follows:

1. Misfiring.
2. Misalignment of engine and shaft.
3. Bent or off-center coupling.
4. Engine loose on bed.

UNCOMMON ENGINE NOISES

The following possible causes of engine noise are more rare, but should be considered and checked in locating foreign sounds.

1. Flywheel loose on crankshaft.
2. Crankshaft pulley loose on flywheel.
3. Loose exhaust pipe at manifold connection.
4. Loose engine accessories, such as generator, water pump, etc.

BACKFIRING AT CARBURETOR

Engine backfiring through the carburetor when starting cold is many times unavoidable as it is the result of imperfect air-gasoline mixture, which will automatically correct itself after the engine reaches normal operating temperatures. The "reason why" of backfiring in this case is late

burning of the mixture in the cylinder, due to improper ratio of fuel to air, igniting the incoming charge and causing an explosion in the intake manifold and carburetor. Thus lean mixtures and retarded spark are the commonest cause of backfiring. Continued backfiring after the engine is warm should be corrected by checking the following possible causes.

1. Excessively lean fuel-mixture.
2. Late ignition timing.
3. Improperly seating valves, especially intake.
4. Obstruction in fuel line.
5. Dirt or water in sediment bowl.
6. Intake manifold air leaks.
7. Poor grade of fuel.
8. Secondary wires crossed in distributor cap.
9. Faulty spark plugs.

ABNORMAL OIL CONSUMPTION

Before deciding that worn piston rings or worn cylinders are the cause of high oil consumption, don't overlook the possibility of oil leaks. Give attention particularly to the oil seals. Slow leaks can be located by spreading a paper under the engine.

If plugs foul up persistently and if the exhaust is smoking, this indicates that the engine may be pumping oil, either past the pistons or along the valve stems. Another cause of fouled plugs is too high an oil level, causing crankshaft to dip and splash excessive oil.

LOW OIL PRESSURE

Complete absence of oil pressure is sure sign of a broken oil pump or lack of oil. Normal oil pressure in a new engine is twenty to thirty pounds.

A pressure of less than fifteen pounds calls for investigation (six to ten pounds is satisfactory at idle). Possible causes of low oil pressure:

1. Incorrect grade of oil.
2. Badly diluted engine oil.
3. Oil relief valve not properly seating. Look for dirt on seat of valve.
4. Clogged oil line.
5. Air leak in oil pump suction line.
6. Sludge on oil pick-up screen.
7. Worn or damaged pump gears.
8. Inaccurate oil pressure gauge.

HIGH OIL PRESSURE

Oil pressure should not exceed thirty pounds except momentarily when the engine is started up cold. Abnormally high oil pressure is not desirable because it increases oil consumption.

Possible causes of high oil pressure:

1. Engine oil too heavy.
2. Relief valve not opening (it may be stuck.)
3. Obstruction in distributing line.
4. Inaccurate oil pressure gauge.

FOULED SPARK PLUGS

1. Worn piston rings.
2. Worn cylinders.
3. Excess piston clearance.
4. Rich mixture.
5. Gap too narrow, causes missing at idle.

BURNED SPARK PLUGS

1. Lean mixture.
2. Late ignition timing.
3. Engine overheated, due to worn water pump, obstructions, etc.
4. Low octane fuel.
5. Badly leaking valves.

POSSIBLE ELECTRICAL TROUBLES

SLOW STARTER SPEED

1. Discharged battery.
2. Loose or dirty terminals.
3. Worn brushes in starting motor.
4. Sticking brushes.
5. Dirty commutator.
6. Burned starter switch contacts.

LOW CHARGING RATE

1. Dirty commutator in generator.
2. Drive belt to generator loose.
3. Voltage Regulator improperly adjusted.
4. High resistance in charging circuit.

HARD STARTING

1. Distributor points burned or corroded.
2. Points improperly adjusted.
3. Wrong gap in spark plugs.
4. Spark plug wires loose and corroded in distributor cap.
5. Loose connections in primary circuit.
6. Corroded battery terminals.
7. Defective condenser.
8. Choke not fully closing.

BACKFIRING

1. Crossed plug wires.
   See "Backfiring at Carburetor" for other causes.

MISSING AT HIGH SPEED — UNDER LOAD

1. Incorrect gap in spark plugs.
2. Defective spark plugs.
3. Defective coil.

PRE-IGNITION

1. Carbon deposits.
2. Overheating.
3. Ignition timing set too early.

FUEL, AIR INTAKE, AND EXHAUST SYSTEM

DESCRIPTION AND DATA

Description. The fuel system consists of a fuel tank, and fuel filter connected between tank and carburetor. The fuel runs into carburetor, where it is mixed with air that has been cleaned by the air cleaner and the mixture is then drawn into the combustion chamber of the engine by vacuum caused by the downstroke of the pistons.

Fig. 103

Air Intake System. The air intake system consists of an oil bath air cleaner which cleans the air, and the cleansed air is then conducted to the air duct of the carburetor.

Exhaust System. The exhaust system carries the burned gas from the engine to the atmosphere. The system consists of an exhaust pipe (exhaust manifold to muffler) and muffler.

DATA

Carburetor:
- Make.....Zenith or Marvel-Schebler
- Model.....Zenith 161
- Model.....Marvel-Schebler TSX-79

Air Cleaner:
- Make.....Donaldson
- Make.....United Specialty
- Location.....Left hand side of sump tank

Fuel Tank:
- Capacity.....5 gallons
- Location.....Over engine

Filler Cap Location:
- Tank over engine Top of hood
- Fuel tank gauge unit On Dash

Governor:
- Make.....Mechanical
- Location.....Front of engine

Fuel Filter:
- Make.....Zenith or A.C.
- Location.....Left side of engine

CARBURETOR

Description. The carburetor is a jet, one venturi, updraft type. It is secured to the intake manifold on the right side of the engine block.

Adjustment of Carburetor. After engine has been warmed up to normal operating temperature, turn idle adjusting screw clockwise onto its seat to make gas mixture "richer" and to the left or in counterclockwise manner to make it leaner.

Removal. Raise side louvers, gas lines and carburetor linkage. Remove stud nuts and lockwashers holding carburetor to intake manifold and remove carburetor and gasket.

Installation: Install new carburetor to manifold gasket and carburetor. Replace fuel lines and linkage.

FUEL LINES

Description. Fuel is conducted from the fuel tank to carburetor by means of metal tubing. All lines are connected by means of a sleeve and a connector. The sleeve is a sliding fit on the pipe and

is inside of the connector which is threaded to complete the connection.

FUEL FILTER

Description. The fuel filter is of the built-up metal disc type and is located between the fuel tank and carburetor assembly. The function of the filter is to remove any water or impurities in the fuel. The filter bowl may be removed for draining any water or sediment which may accumulate in the filter bowl.

GOVERNOR ADJUSTMENT

1. Raise left hand louvre sheet to locate.
2. Adjust carburetor (if needed).
3. Adjust accelerator linkage by checking looseness of governor lever attached to accelerator linkage. There are four holes in governor arm for purpose of changing spring tension on accelerator linkage.

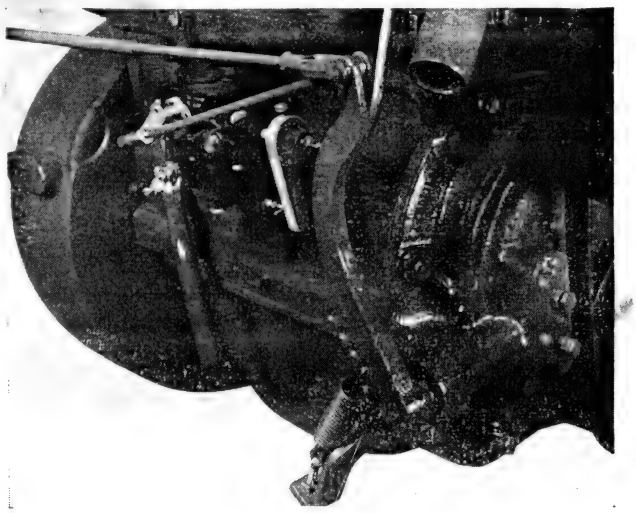


Fig. 104

4. To remove surge from governor, turn top governor adjusting bolt (on timing gear cover next to fan belt) to the right. This slowly increases engine R.P.M. Turn to limit and then back off to correct surge. Set lock nut.

CARBURETOR — ZENITH

Removal

1. Disconnect choke at carburetor.
2. Turn off gasoline flow at petcock.
3. Disconnect accelerator linkage at carburetor.

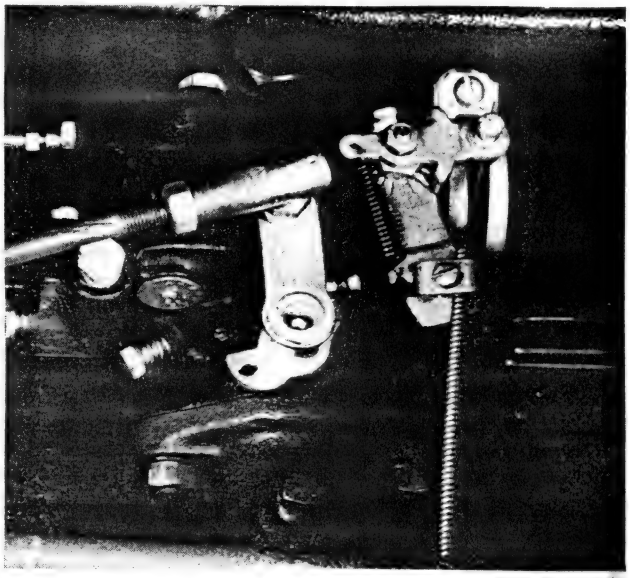


Fig. 105

4. Disconnect air cleaner tube at carburetor.
5. Disconnect gasoline line at gasoline filter.
6. Remove two nuts holding carburetor to manifold.
7. Remove carburetor.

Installation

1. Clean entire carburetor and replace all parts which may be worn.
2. Reassemble carburetor and install to manifold using new gasket.
3. Install two nuts holding carburetor to manifold.
4. Connect gasoline line at gasoline filter.
5. Connect air cleaner tube at carburetor.
6. Connect accelerator linkage at carburetor.
7. Turn on gasoline at tank petcock.
8. Connect choke at carburetor.

CARBURETOR — MARVEL SCHEBLER

Disassembly —

1. Remove screws attaching upper to lower body.
2. Remove throttle valve and shaft.
3. Remove choke valve and shaft.
4. Remove float and lever assembly, needle valve, seat, and all jets.

Assembly —

1. First, clean entire units in good carburetor cleaner.
2. Replace all parts which may be worn.

ZENITH CARBURETOR

Disassembly —

1. Loosen lever clamp screw and remove lever. Remove idling adjusting screw and spring.

2. Remove four throttle body to bowl assembly screws with a screwdriver. Raise the throttle body slightly and loosen the gasket from the bowl assembly.

3. Lift the throttle body and gasket cleat of the bowl assembly, being careful not to damage the float. Remove the venturi.

4. Remove the float axle using a screwdriver to push the axle from the slotted end of the bracket, and the fingers to remove it the rest of the way. Remove the float assembly and the float needle valve.

5. Remove the throttle body to bowl gasket. Remove the fuel valve seat and gasket.

6. Remove idling jet using a small screwdriver with three-sixteenths inch blade. Remove the throttle plate screws, plate and shaft assembly.

7. Remove stop lever taper pin using a small punch and a hammer. Remove the throttle shaft packing retainers and packings using a screwdriver or a small pair of pliers to lift out the retainers. (Some models use a shaft hole plug which can be removed with a small drift and a light hammer.)

NOTE: Do not remove the identification disc which is riveted to the bowl cover, the priming plug, the throttle stop pin, the float hinge bracket, or the brass channel plugs.

8. Remove the well vent using a small screwdriver. (three-sixteenths inch blade) Remove the main discharge jet and gasket.

9. Remove main jet adjustment assembly (or plug) and gasket using a one-half inch open end wrench. Remove main jet and gasket, using suitable screwdriver.

10. Remove air shutter lever retainer nut and lockwasher using a five-sixteenth inch wrench. Remove air shutter lever assembly.

11. Remove air shutter bracket retainer screw and bracket using a one-half inch wrench. Remove air shutter shaft hole plug and gasket using a one-half inch wrench.

12. Remove air shutter screws and lockwashers. Remove air shutter plate and shaft. NOTE: Do not remove air vent channel brushing, air shutter stop pin, air shutter bracket locating pin, or drip plug.

13. Clean the bowl and throttle body casting in solvent and blow through each channel with compressed air to make sure that all channels are clean. Refer to section titled "Parts to be replaced," for list of parts which we recommend replacing when overhauling this type of carburetor.

PARTS TO BE REPLACED

In most cases the following parts should be replaced when overhauling this type of carburetor.

1. All gaskets
2. Fuel valve and seat assembly
3. Main jet
4. Idling jet
5. Main discharge jets are used in the series No. 61. The dash (—) number and the size are stamped on the jet body. Be sure to use same type as removed.
6. Well vent
7. Float assembly
8. Float axle
9. Throttle shaft
10. Air shutter shaft
11. Throttle shaft hole plug
12. Packing cup
13. Packing washer (uses two)
14. Cotter pin
15. Taper pin
16. Plate screw

ASSEMBLY

1. Place air shutter shaft in position. Install air shutter plate screws and lockwashers. Be sure air shutter valve is in correct position, and that the air shutter plate is properly centered before tightening the screws securely.

2. Install air shutter shaft hole plug and gasket using a one-half inch wrench. Hold air shutter bracket in position.

3. Install retainer screw using a one-half inch wrench. Install air shutter lever assembly as follows:

A. Hold the air shutter in wide-open position.

B. Place the lever on the shaft and against the stop pin in the direction to open.

C. Install retainer nut and lockwasher using a five-sixteenths inch wrench.

D. Check operation to make sure the air shutter opens and closes fully.

4. Replace main discharge jet and new gasket. Install main jet adjustment (or plug) and new gasket using a one-half inch open-end wrench.

5. Replace main discharge jet and new gasket. Replace well vent using a small screwdriver (no gasket required.)

6. Place new throttle shaft packing in new packing retainer ring. Install packing retainer ring (with packing) in both throttle shaft bosses using a light hammer.

7. Place new throttle shaft in position. Install throttle plate. The throttle plate should be properly centered before tightening the screws and lockwashers securely.

8. Install stop lever assembly on the throttle shaft. NOTE: When the throttle plate is straight up and down in the barrel (wide open) the stop lever should be against the stop pin.

9. Replace idling jet using a small screwdriver (no gasket required). Replace fuel valve seat and new gasket.

10. Place new throttle body to bowl gasket in position. Place fuel needle in position followed by the float assembly.

11. Install float axle using the handle end of a screwdriver to strike the end of the axle to force it into the slotted end of the bracket. The float should move freely on the axle. Check position of float to obtain correct fuel level. The dimensions should be one and five-thirty-seconds inch plus or minus three-sixty-fourths inch (Move the gasket to one side while making the measurement).

12. Place the venturi in position in the throttle body. NOTE: Venturi has a locating boss that fits into a groove in the throttle body.

Place the bowl assembly in position of the throttle body, being careful to avoid damaging the float.

13. Install assembly screws and lockwashers. Be sure to tighten the idling adjusting screw and spring.

14. NOTE: As a preliminary adjustment, set the idling adjustment and the main jet adjustment at one full turn open and adjust the throttle stop screw to hold the throttle just slightly open. Install throttle lever and tighten the clamp screw.

Note — **A**

The location of the priming hole plug in relation to the throttle plate is extremely important for uniform idling and part throttle operation. To maintain a uniform relation between the priming hole plug and the throttle plate, the factory assembles the throttle shaft and plate in the throttle body before drilling the body for the priming hole plug, locating the hole in a definite relation to the throttle plate in each case. It is readily apparent from the above that throttle plates and throttle bodies cannot be interchanged indiscriminately. When it becomes necessary to replace the throttle shaft or throttle plate employ the following routine:

1. Unscrew the throttle stop screw to permit complete closing of the throttle plate.

2. Hold throttle in tightly closed position and mark the inside of the throttle body close to the throttle plate with a steel scriber.

3. Using this scribed line as a guide, replace the throttle shaft or plate. If new plate used shows a noticeable variation from old one, select another new plate to get one that fits very close to the scribed line when installed.

4. If throttle body has to be replaced, obtain a complete throttle body assembly including shaft, plate, priming hole plug, etc., built to the outline number which appears on the identification disc on the bowl cover.

MANIFOLD AND GASKET

Exhaust Manifold. The exhaust manifold is made in one section and is held to cylinder block by studs and nuts. The exhaust manifold conducts burned gas away from the cylinder.

Intake Manifold. The intake manifold is secured to the exhaust manifold by studs and nuts. It carries the atomized fuel from the carburetor to the engine combustion chambers. Gaskets are between manifolds and the cylinder block.

EXHAUST AND INTAKE MANIFOLD REMOVAL

Remove side louvers, carburetor and linkage, exhaust pipe, stud nuts, and lift manifold assembly and gaskets off studs.

EXHAUST AND INTAKE MANIFOLD INSTALLATION

Replace manifold gaskets and manifold assembly on studs. Install stud nuts and tighten. Install exhaust pipe to manifold. Install carburetor assembly and linkage. Lower side louvers.

FUEL SYSTEM TROUBLE SHOOTING GUIDE CARBURETOR

1. No fuel flow at carburetor. Leakage in system, check entire system from fitting at bottom of fuel tank, along the lines to the fuel filter and carburetor, for evidence of fuel leaks. Tighten loose fittings and replace defective parts.

2. Clogged fuel system. Check the entire system for obstructions in the units, starting at the fuel tank end of the system.

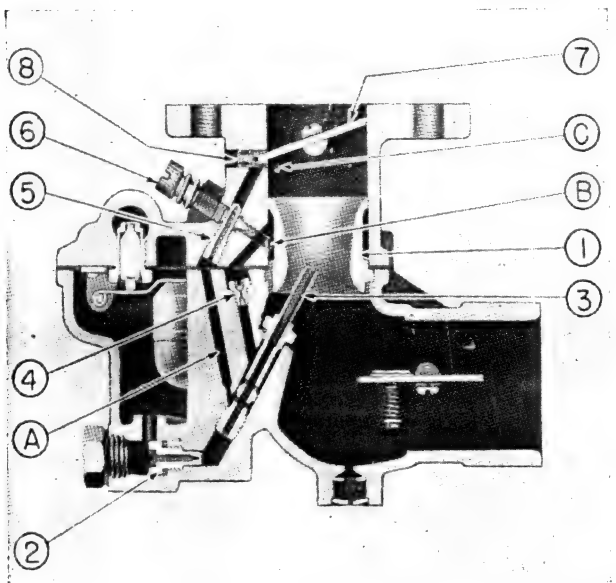


Fig. 106

3. Faulty engine performance, with full fuel flow at carburetor. Impurities in system, impurities, such as water and oil, can be detected in the sediment bowls of the fuel filter. Remove these units, being careful not to empty them in so doing. By slowly pouring out the contents, any impure solutions can be seen at once, as they will not mix with the fuel. Condensation of air, caused by rapid temperature changes, often produces a considerable amount of water in the fuel tanks. If the check shows water deposits in the sediment bowls, clean them, then drain the tank of a gallon of fuel. This should remove the water from the system.

4. Clogged air cleaner system. Check air cleaner screens for clogged condition. Wash screens in solvent and replace filter oil.

5. Faulty carburetor action. With engine running, adjust carburetor mixture at spring screw at top of carburetor.

6. Faulty carburetor controls. Check the setting and operation of the choke butterfly valve in the carburetor intake. Make sure that its normal position is maintained.

7. Draining Carburetor — Raise left hood louvre and remove drain plug from bottom of carburetor, remove gas filter bowl, cork washer from cap and laminated screen. Clean out filter bowl and replace with new cork washer and clean out laminated screen in solvent and replace parts.

Note — **B**

A round aluminum identification disc riveted to the carburetor bowl cover specifies the assembly outline number to which the carburetor was originally built. When ordering special parts such as throttle bodies, throttle lever and stop lever assemblies, etc., be sure to specify outline number of the carburetor to prevent errors in selecting parts required.

Note — **C**

Rebushing the throttle shaft bearings, is an operation that should not be attempted unless the shop is properly equipped for such work.

EXCESSIVE GASOLINE CONSUMPTION

Causes

1. Caused by type of operation
   a. Sustained high operating speeds.
   b. Long period of idle operation.
   c. Abnormally fast engine idle speed.

2. Caused by units other than the carburetor
   a. Faulty ignition due to:
      1. Incorrect timing (especially late ignition).
      2. Improperly spaced distributor points.
      3. Weak ignition condenser.
      4. Weak ignition coil.
      5. Cracked or chafed wiring insulation.
      6. Defective or incorrectly spaced spark plugs.
   b. Restricted or partially clogged carburetor air cleaner.
   c. Abnormal rolling resistance due to:
      1. Dragging brakes.
      2. Tight wheel bearings.
   d. Poor engine compression.
   e. Partially clogged or restricted exhaust pipe, muffler, or tail pipe.
   f. Pre-ignition.
3. Condition caused by improper carburetor adjustment.
   a. Float level too high.
   b. Float leaking and partially filled with fuel.
   c. Float needle valve leaking.
   d. Internal leakage in carburetor due to:
      1. Fractured passages.
   e. Loose plugs or damaged gasket at base of main discharge jet nozzles.
   f. Carburetor throttle stop screw set too fast.
   g. External carburetor leaks.
4. Leaks occurring in the gasoline tank or lines.

MANIFOLD LEAKS—INTAKE AND EXHAUST

Causes

1. Loose manifold connectings or leaks occurring in vacuum lines (intake manifold).
2. Loose manifold nuts.
3. Insufficient threads on manifold attaching stud permitting nuts to bottom.
4. Distortion or misalignment existing at gasket surfaces on:
   a. Intake manifold.
   b. Exhaust manifold.
   c. Carburetor attaching flange.
5. Damaged or improperly installed gaskets.
6. Restriction in exhaust pipe, muffler, or tail pipe (excessive back pressure).

HYDRAULIC SYSTEM

The hydraulic system consists of the oil sump, engine driven hydraulic oil pump, hydraulic valve with lift and tilt control handles, the lift cylinder, and the tilt cylinders. The oil sump holds enough hydraulic oil to actuate both lift and tilt to the maximum displacement and a reserve to prevent oil temperature build up.

The hydraulic pump is driven by the engine. When the lift and tilt handles are in center oil from pump passes through the relief valve and back into the sump. The hydraulic pump converts the static oil in the oil sump into a high velocity stream of oil to give necessary pressure to operate the lift or tilt pistons.

If the lift handle has been moved to the rear, the lift valve has been opened allowing the oil from the pressure side of the pump to go through the valve and into the bottom of the lift cylinder. This oil pressure will move the lift piston up. When the lift handle is centered, the valve returns to neutral. With the valve in neutral, oil is trapped in the lift piston so that the load will be held by the forks to the height lifted. Moving the lift handle forward will open an orifice in the valve to vent the oil in the lift cylinder into the sump. The weight of the forks will force the piston down and the oil returns through the line and valve to the oil sump. There is a vent line connected between the upper end of the lift cylinder and the oil sump.

The tilt cylinder operates the same as does the lift, except that both ends of the tilt cylinder are connected to the valve. Hydraulic pressure is used to tilt either forward or back. If, for instance, the tilt handle is pushed forward for forward tilt, hydraulic pressure from the pump comes into the rear of the tilt cylinder by way of the valve. The front hose is connected through the valve to the oil sump to bleed off oil in the front end of the piston. When the handle is pulled to the rear the reverse is true. The front line takes pressure from the valve and the rear line bleed off oil in the rear of the cylinder through the tilt valve and into the oil sump. When the tilt handle is centered oil is trapped in both the front and rear sides of the tilt cylinder to hold the desired degree of tilt.

HYDRAULIC PUMP REMOVAL — VICKERS

Unlatch and lower the right hand side louver.

Drain the oil sump at the drain plug on the sump well.

Disconnect the pump intake line at the pump and the pressure line at the pump.

Remove the four cap screws and one through bolt that holds the pump adaptor plate to the timing gear cover. Maneuver the pump and adaptor assembly off the mounting flange.

HYDRAULIC PUMP DISASSEMBLY—Vickers (See Fig. 107)

Punch out the pump drive gear retaining nut lock. Remove the gear retaining nut and lift off the lockwasher.

With a gear puller pull the pump drive gear off the pump shaft. The gear is keyed to the pump shaft with a woodruff key. Remove the key from the pump shaft.

Remove the two cap screws that secure the pump to the adaptor plate. Remove the adaptor plate.

Remove the four hex head cap screws that hold the pump end cap to the pump body. Lift off in order the pump end cap, port plate spring, port plate, pressure plate, and the rotor with the vanes. There is an "O" ring on the end cap to provide an oil seal between the end cap and pressure plate. There are arrows milled on the outside edge of the pressure plate. These arrows should point in the direction of rotor rotation. The rotor vanes are rounded on one edge. The vanes should fit in the rotor with the rounded edge against the pressure plate. There is also an "O" ring between the pump body and the pressure plate to provide an oil seal.

Remove the snap ring that holds the driven end bearing to the pump body. Use a gear puller or an arbor press to take the pump shaft and driven end bearing out of the pump body. With an inside gear puller remove the oil seal and spacer from the pump body. Pull the rotor end bearing from the pump body with a gear puller.

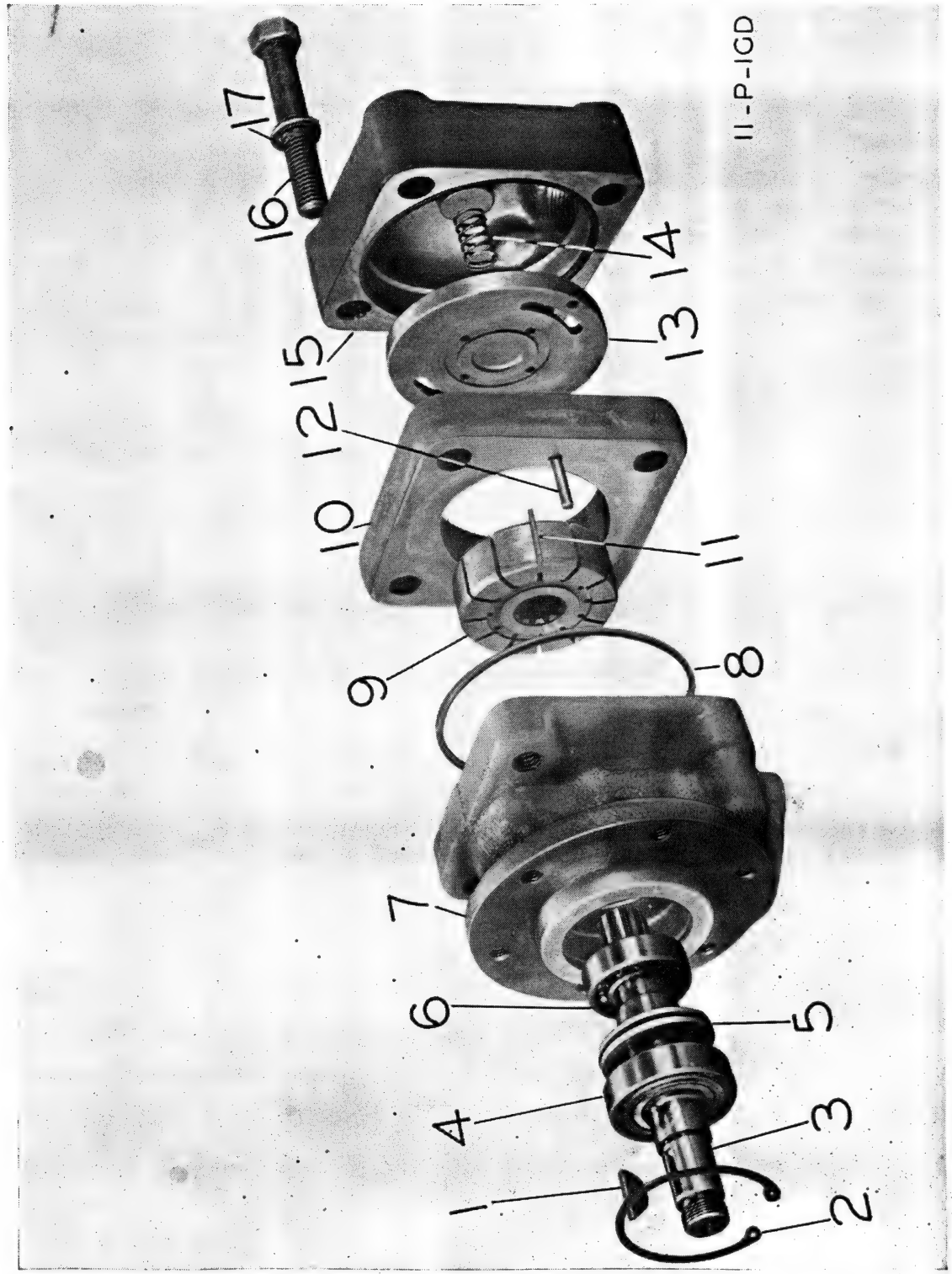


Fig. 107

PUMP MAINTENANCE — VICKERS

It is advisable to replace the "O" rings and oil seal anytime the pump is disassembled for repairs.

Clean all parts in solvent and dry with compressed air. The bearings should be cleaned separately in clean solvent. Do not allow the bearings to spin while drying.

Inspect the bearings for rough or high spots. Replace the bearing if any rough spots are found.

Inspect the pump drive gear for broken, chipped or bad teeth. Remove the raised edge of any burrs with a fine stone.

Check the pump body, pressure plate, port plate, and end cap for any breaks, burrs or turned edges.

Inspect the rotor splines, vanes, and rotor for rough edges, burrs, or cracks.

Replace any defective parts that may be found.

PUMP REASSEMBLY — VICKERS
(See Fig. 107)

Fit the rotor end bearing in place in the pump housing and use an arbor press to press the bearing into its seat.

Put the oil seal and spacer into place in the pump housing and press into place with a press.

Set the pump shaft into the opening through the oil seal and with an arbor press seat the driven end bearing and shaft into place in the pump housing. Secure the driven end bearing in place with the snap ring.

Install the pressure plate on the dowel pins being sure that the arrows on the edge of the plate are pointing in the direction of pump rotation.

Be sure the "O" ring is on the pump body.

Fit the rotor in place on the pump shaft carefully meshing the splines.

Install the rotor vanes in the slots of the rotor. Be sure that the round edge of the vanes fit against the pressure plate.

Put the port plate over the dowels and seat against the pressure plate. Set the port plate spring in the recess on the port plate. Install the "O" ring on the end cap and fit the end cap in place against the pressure plate. Turn in the four end cap screws that secure the end cap to the pump body.

Put the pump in place on the adaptor plate with a new gasket and install the two cap screws that hold the pump to the adaptor plate.

Put the woodruff key in the slot in the pump shaft. Fit the drive gear on pump shaft lining up keyway with key and press the gear on to the shaft.

Use a new nut lock and turn on the pump drive gear retaining nut. Punch over the face of the lock to hold the nut in place.

HYDRAULIC PUMP INSTALLATION—Vickers

Maneuver the pump assembly into place on the mounting flange carefully meshing the gear with crankshaft gear. (Use a new gasket between the adaptor flange and gear case). Install the four cap screws and one through bolt that hold the adaptor cover to the gear case.

Connect the pump intake and pressure lines to the hydraulic pump. Fill the oil sump with hydraulic oil.

Start the engine and operate both lift and tilt. Check the installation for leaks.

EATON HYDRAULIC PUMP

DESCRIPTION

The Eaton Rotor Pump has a specially designed rotor set pumping element in which the inner and outer members are mutually generated. The inner rotor is keyed to the shaft and drives the outer rotor which runs in a bore offset from the shaft. The generated tooth form results in a rolling and sliding contact against each other which cause cavities to open and close. This action is smooth and uniform and occurs through a large number of degrees of rotation resulting in a quiet operation and long life due to the absence of shock loads.

DATA

Gallons per minute at 1000 psi. @ 1200 rpm pump speed	11.5 gal.
Pump Speed	2/3 Engine Speed
Allowable Clearance Between Body Bushing and Outer Rotor	Max. .006 in.
	Min. .0025 in.

Total End Clearance Between Outer Gear and Body	Max. .0026 in. Min. .0015 in.
Total End Clearance Between Inner Gear and Body	Max. .0031 in. Min. .0020 in.
Cover to Adapter Body Screws (Torque)	30 to 35 ft. lb.

DISASSEMBLY

Disassembly of the pump consists of removing four cover screws (Fig. 108, reference —), with lockwashers. Tap edge of cover and adapter lightly to free dowels (7) and cover (6) and remove the adapter (2), gasket (3), "O" ring (4) and cover (6) following which the rotors (8) will slide from shaft (15). Remove rotor to shaft key (10) and lift off cover to body gasket (9). Remove the bearing retainer ring (18) that locks the shaft and bearing (17) to body (11) then remove the shaft and bearing assembly as a unit. Using a suitable tool, remove the snap ring (16) from the shaft and press bearing from shaft using an arbor press.

CLEANING AND INSPECTION

Following complete disassembly of the pump as described in the forgoing paragraph, clean all parts thoroughly in a suitable cleaning solvent and dry with compressed air. Use extreme caution when handling all parts to avoid any nicks or chips due to dropping or bumping against solid objects. Inspect the bushings and oil seal and replace when evidence of wear is shown.

BODY BUSHING

To remove the body bushing use a hammer and cold chisel with a flat point similar to a screwdriver or other suitable tool. Hold the chisel at an angle inward at a point near the split in the bushing and tap firmly to collapse the bushing toward the center of the pocket. (See Fig. 108). Following the opening of the bushing as shown in Fig. 108, use a large screwdriver to finish collapsing the bushing toward the center. The bushing will now drop out. Care must be exercised during removal to avoid scoring the wall of the pocket. Following removal, inspect wall for score marks or burrs and if these are present, remove same before installing new bushing. Lubricate wall of bore and position new bushing into opening being sure it fits squarely. Align split in bushing with centerline between narrow end of ports. Using a suitable piloting tool, press bushing into place so that edge of bushing is just below the face of the body.

COVER BUSHING

To remove the cover bushing, place cover in arbor press and press out old bushing, using a pilot tool one-sixty-fourth inch smaller than the outside diameter of the bushing. Inspect the cover bore for score marks or burrs and remove same before installing new bushing. Clean parts thoroughly and lubricate the bore. Align bushing on rotor side of cover with open end of groove facing outward and the split in the bushing located with centerline between the wide end of the ports. Press in bushing, using pilot shaft so that edge of bushing is .12 inch below the rotor face of the cover.

OIL SEAL

To replace the oil seal, use a chisel with a flat point similar to a screwdriver and hold it against the inside edge of the seal from the pocket side. Tap chisel lightly with hammer to drive out seal. Care must be used to avoid damage to casting. Position new seal with lip toward rotor pocket in body and press solid with an arbor press being careful to avoid damage to seal. Apply a film of Lubriplate or similar grease over seal lip.

REASSEMBLY

(See Fig. 108)

When reassembling the pump it is important that all parts are clean. Do not wipe parts with cloths. Use new gaskets whenever pump is serviced. Assemble the retaining ring (Fig. 108, reference —) on the shaft in the groove. Using an arbor press, press the bearing (17) on the shaft. Insert shaft (15) through seal (14) into body (11). Using proper tool or a pair of long nosed pliers, insert the ball bearing to body retaining ring (18) into the groove to lock the ball bearing and shaft into body. Place the drive key (10) into keyseat and slide on rotor. Lubricate the inner and outer rotor (8) and assemble the outer rotor into place. Install the body to cover gasket (9) in the groove and align body to cover so that dowel pins (7) align with holes in body. Place a new gasket (3) and "O" ring (4) into cover and

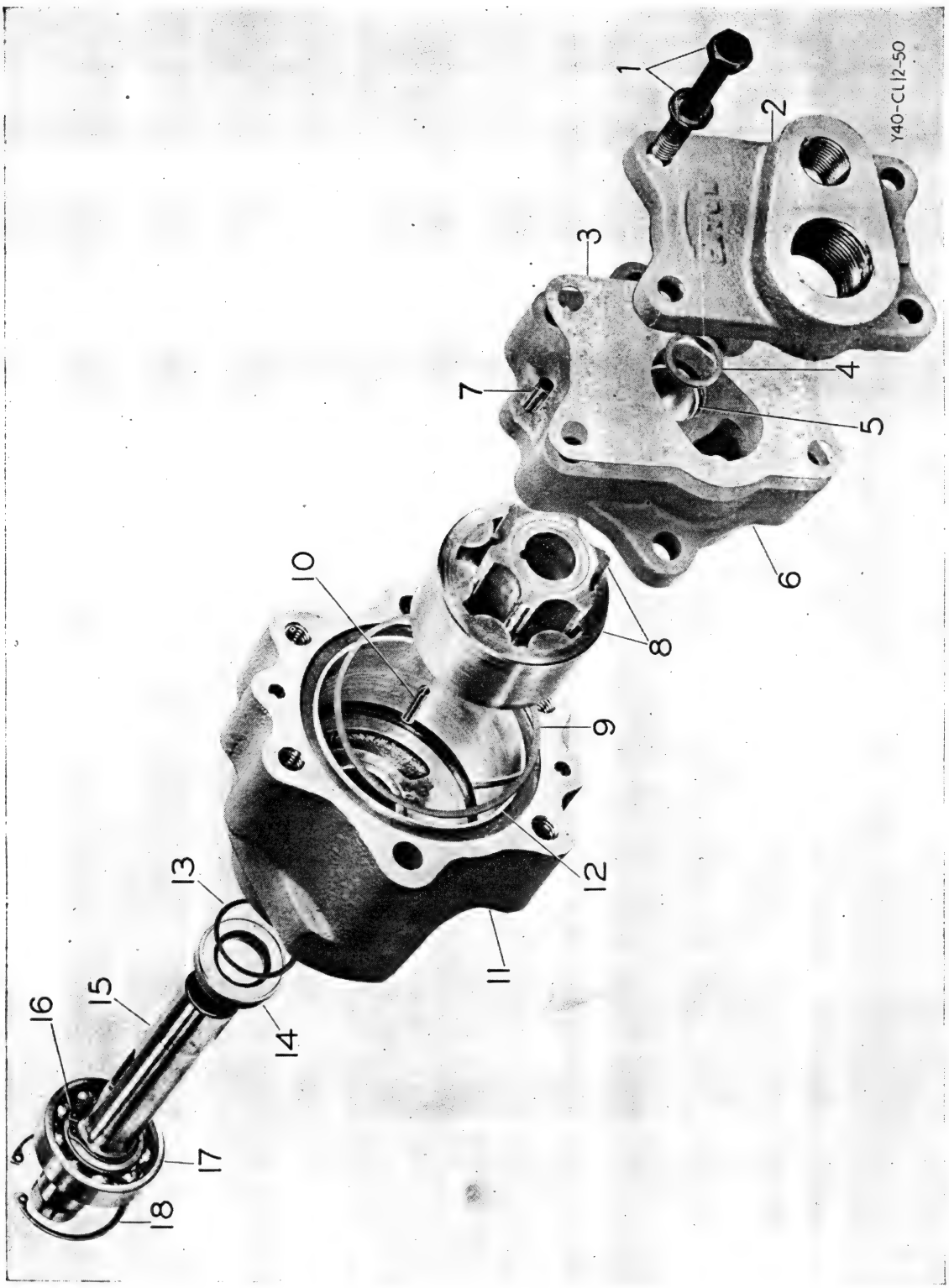


Fig. 108

replace pipe thread adapter (2). Install the four bolts and lockwashers and tighten the bolts to thirty to thirty-five foot pound, then turn pump shaft by hand to make certain it turns freely before installing pump into engine.

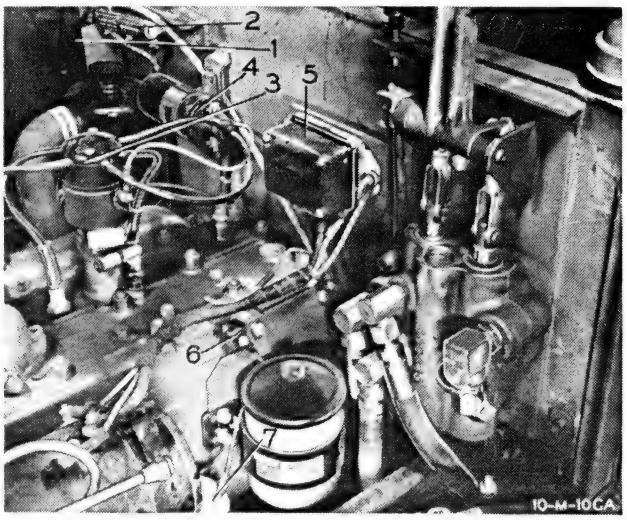


Fig. 109

HYDRAULIC SUMP TANK REMOVAL

Drain sump tank and proceed as follows:

1. Remove hand choke assembly.
2. Disconnect air cleaner to carburetor hose at air cleaner.
3. Disconnect all oil lines at hydraulic valve.
4. Disconnect oil return line at hydraulic pump.
5. Disconnect battery ground cable at battery.
6. Remove brackets holding accelerator linkage to sump tank.
7. Remove six bolts holding sump tank to frame.
8. Disconnect and mark wires at terminals on voltage regulator, coil, resistor coil, and safety switch.
9. Lift sump tank and attached assemblies from machine.

HYDRAULIC SUMP TANK WELL

REMOVAL

1. Raise right hood louvre and disconnect pump to valve hose line at the valve end.
2. Place clean container at right side of valve.

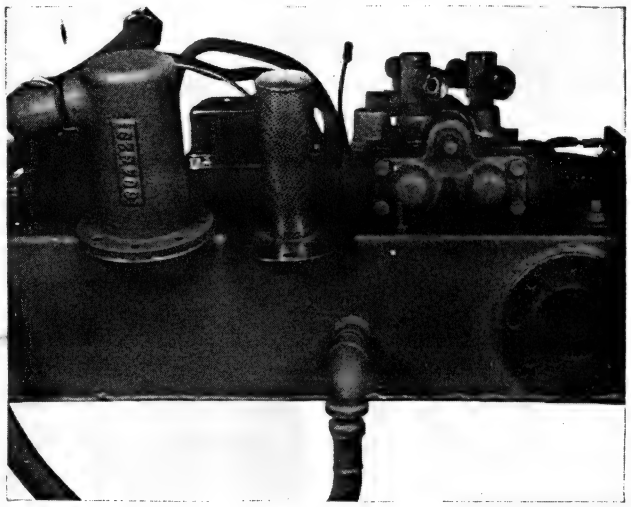


Fig. 110

3. Start motor and operate at idle speed.
4. Pump hydraulic oil into container by using the tractor motor, until all oil has been pumped out of sump tank.
5. The sump tank well is located on the bottom of the sump tank on the right side.
6. Remove eight mounting capscrews and remove well from the bottom of the tank.
7. The screen is located in the well and has a gasket on the top and one on the bottom of the screen flanges.
8. Replace gaskets when cleaning tank well and use an oil sealer on both side of gaskets and on threads of the capscrews when replaced.
9. Clean out sump well with gasoline and blow out screen with forced air.

REPLACEMENT

1. Replace new gaskets at tank well flange. Seal these gaskets on both sides with permatex sealer and also on the threads of the capscrews when replacing.
2. The gaskets are located on the top of the well flange and one on the bottom of the well flange of the screen.
3. Place the screen and gaskets in location and replace the eight mounting capscrews, drawing them up finger tight before tightening down.

4. Replace hydraulic oil in sump tank.
5. Connect hydraulic hose to valve and pump.
6. Start motor and operate at idle speed, checking the operation of the lift and tilt control levers and the pump operation.

LIFT AND TILT VALVE

Description: The lift and tilt valve consists of three control parts. The lifting spool, the tilting spool and the relief valve. The position to which these parts may be moved control the points and amount of available pressure applied.

Removal Procedure:

1. Disconnect hydraulic hose and lines from valve.
2. Disconnect control levers from valve spool ends.
3. Remove bolts holding valve to back of sump tank.

Disassembly:

1. Remove capscrews and washers holding valve section together.
2. Take sections apart being careful not to damage gaskets.
3. Remove light set screws holding valve spool closes end covers.
4. Pull out spool assemblies.
5. From opposite side at spool extended end side remove four slotted head screws holding oil seal retainer plates.
6. Oil seals can be driven out if worn enough to justify replacement.
7. Remove relief valve acorn nut, jam nut, adjusting screw, spring and ball from relief valve opening.

Cleaning, Inspection and Repair: Clean all parts and inspect for wear or damage.

Assembly: (See Fig. 111)

1. Re-install ball and spring, adjusting screw, jam nut, relief valve acorn nut in relief valve opening.
2. Re-install oil seals.
3. Re-install four slotted head screws holding oil seal retainer plate.
4. Re-install spool assemblies.
5. Re-install eight set screws holding valve spool closed end covers.
6. Re-install gaskets between sections.
7. Re-install capscrews holding valve section together.

Installation Procedure:

1. Place valve in position on back of sump tank and re-install bolts and tighten.
2. Connect control levers to valve spool ends.
3. Connect hydraulic hose lines to valve.

Adjustments and Tests: Test valve for load holding making sure the fault is not lift or tilt cylinder leathers. If action is too slow, adjust relief valve to speed pickup and tilt action.

TILT CYLINDERS

Description: The tilt cylinders are of a cylindrical shape, two being used, one on each side of, and to the rear of the uprights. They are used for the purpose of tilting the uprights forward and backward.

Removal:

1. Remove grease fitting at front tilt cylinder to upright bracket pin, remove cotter pin from front. Drive tilt cylinder pin out.
2. Disconnect hydraulic lines from valve to tilt cylinder and disconnect the tilt cylinder cross lines at one side.
3. Remove both floor boards and the front cross member.
4. Remove cotter pin from rear tilt cylinder pin, remove grease fitting from rear tilt cylinder pin.
5. Drive out front tilt cylinder pin, with brass punch. After grease fitting has been removed from rear tilt cylinder; make up suitable shaft about eighteen inches long with a nut on the end and some flat washers acting as a bumper, use a piece of pipe over the shaft as a knocker; the knocker to be about five inches long; in using the knocker against the washers, the tilt cylinder pin can be pulled out of the boss and through the hole in side of frame.

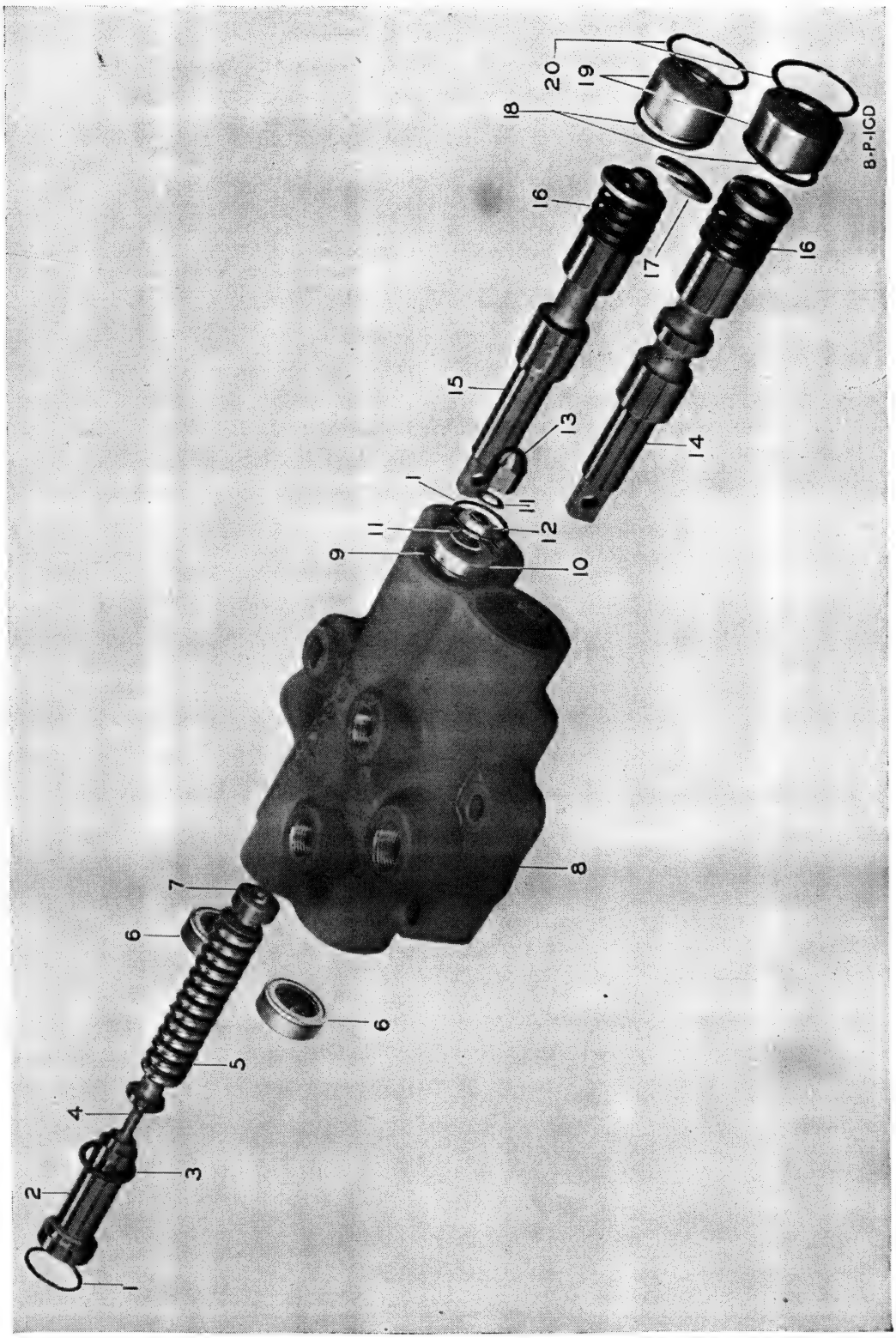


Fig. 111

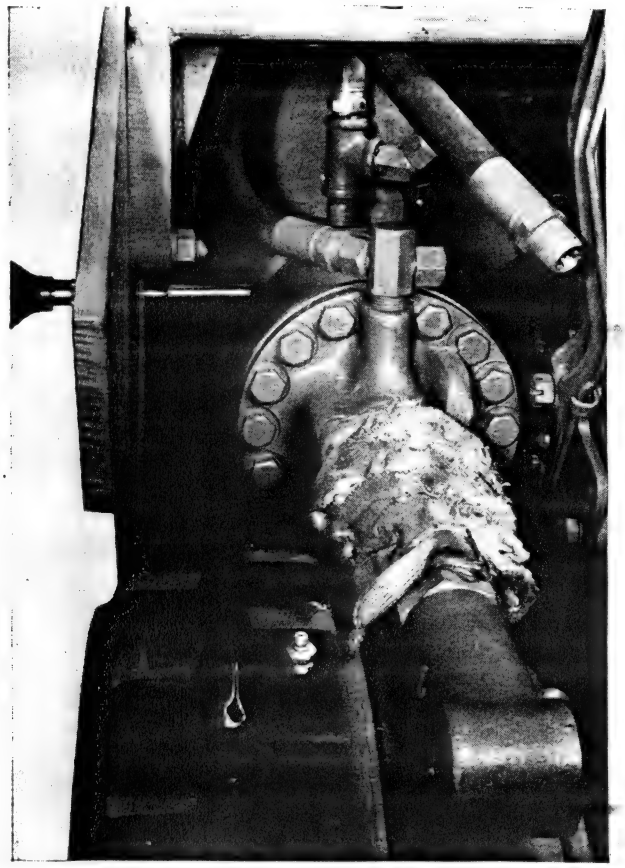


Fig. 112

This allows the tilt cylinder to be removed from the machine and pulled out from the front.

Disassembly:

1. Loosen boot clamp and squeeze cover on piston rod.
2. Remove cotter pin from piston rod end and unscrew rod end.
3. Remove large lock nut from piston rod and slide boot off rod.
4. Remove bolts holding cylinder gland and remove gland, pull backing from gland.
5. If necessary to remove bushings from gland or gland end, use an arbor press with suitable blocking.
6. Pull piston and rod from cylinder and slide spacer off rod.
7. Remove cotter pin and piston rod nut leaving piston assembly free for removal from rod.
8. Remove capscrews from both sides of piston leaving clamping plates and leather free for removal from piston.

Cleaning, Inspection and Repair: Clean all parts with solvent and inspect for wear. If new leathers are required on piston, soak new leather for thirty minutes in clean SAE No. 10 motor oil, or neatsfoot oil heated to 160° to 180°.

Reconditioning Tilt Cylinders:

1. Drain oil from tilt cylinder.
2. Remove capscrew holding head of cylinder to body and separate head, piston and shaft as an assembly.
3. Inspect body of cylinder for foreign matter, scores in cylinder and for leaks in welds.
4. Remove clamp nut holding piston head to the shaft.
5. Unscrew the piston head assembly from the shaft by holding the shaft clamped in a vise using brass covered jaws.
6. To remove rod end assembly, loosen jam nut, remove cotter pin and unscrew.
7. Remove capscrews from piston cup plates, install new leathers and reassemble cup plates, securing capscrews with lockwire.
8. Reassemble to piston shaft by turning clamp nut and secure with cotter pin.
9. Remove packing gland assembly from cylinder head, determine wear of bushing in gland end assembly.
10. Inspect bushing for wear in cylinder head, replace bushings if necessary.

Re-Assembly:

1. Install leathers on piston, replacing clamping plates in place and replace capscrews.
2. Secure capscrews.
3. Place piston assembly on piston rod and replace nut and cotter pin holding piston to rod.
4. Make sure tilt cylinder is free from dirt and other foreign matter.
5. If air hose is available clean cylinder with compressed air.

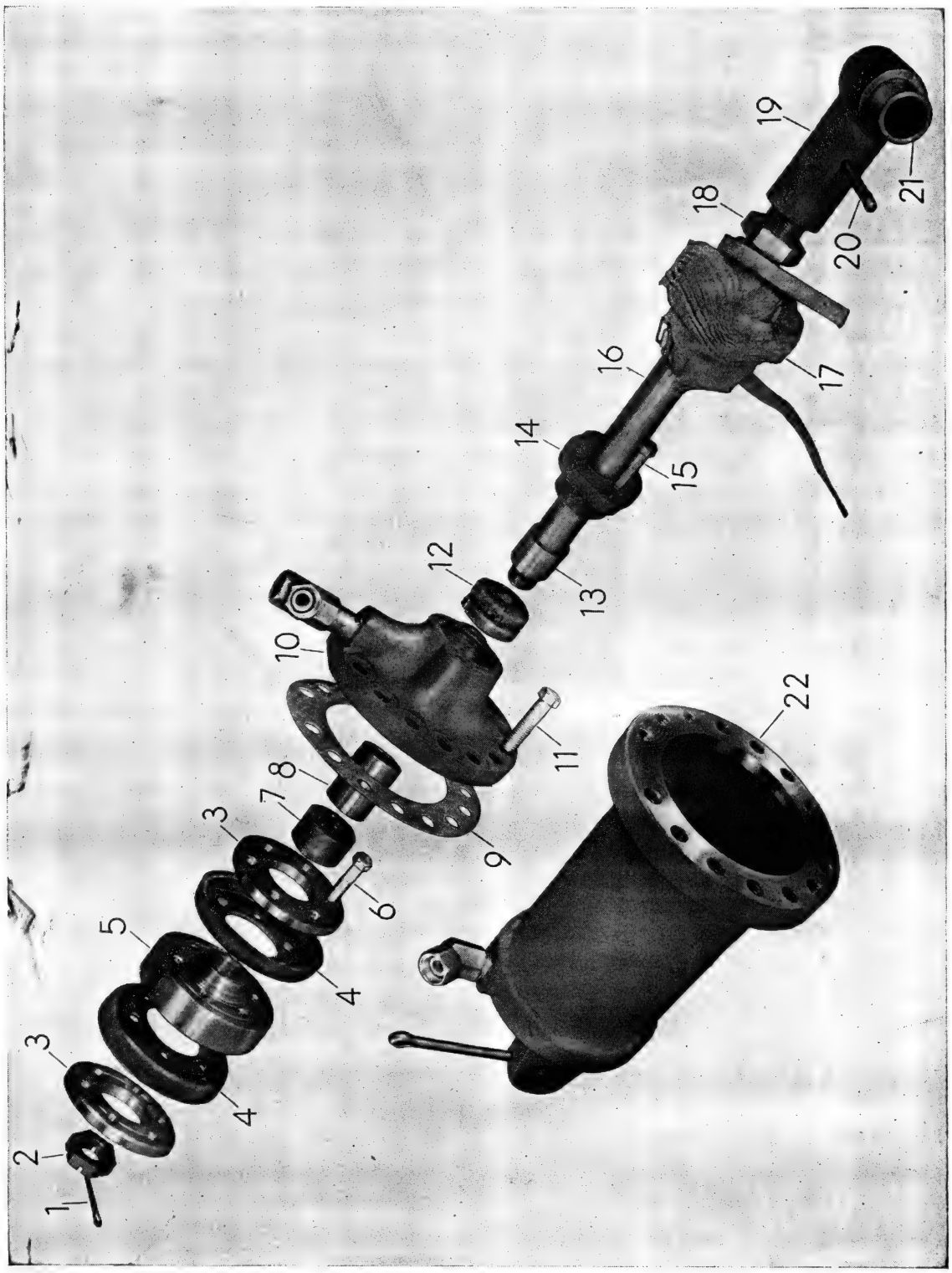


Fig. 113

6. Install piston and rod assembly in cylinder and slip piston spacer over rod against piston.
7. With bushings in place fit gland and gasket securely over rod and fit to cylinder.
8. Lock jam nut and install cotter pin, secure both and install floor boards and front cross member.

Adjustments and Tests:

1. The jam nuts on the tilt cylinder shafts should be adjusted equally, if not, the upright will not tilt with equal length to tilt cylinder shafts.
2. This may cause torque when upright is tilted forward or back, and may cause binding if the adjustment of the piston rod end is too far off.
3. Adjust piston rod end so that correct amount of tilt is obtained.
4. Test with load and uprights vertical.
5. If cylinder is operating satisfactorily, capacity load will stay in tilted position and will not creep forward.
6. Pick up a capacity load with the vehicle and place the hand control lever in the neutral position. If the load creeps forward, the leathers in the tilt cylinder piston must be replaced.

UPRIGHT ASSEMBLY

Description: The upright assembly is made of two vertical channels with inner slides and contains the lift cylinder. It provides a track for the inner slide and lift bracket and roller assemblies. The lift fingers are fastened to the bumper bars which are bolted to the lift brackets.

Removal of Upright: Remove lift fingers from bumper bars. Fasten chain hoist to upright for support. Remove hydraulic lines from lift cylinder. Remove pins connecting tilt cylinders to upright. Remove bolts, bearing caps, and bearings, holding upright assembly to frame upright support. Maneuver upright away from machine.

Disassembly of Upright: With upright supported by chain fall, proceed as follows:

1. Remove fourteen bolts that hold the two finger bars to the lift bracket assemblies.

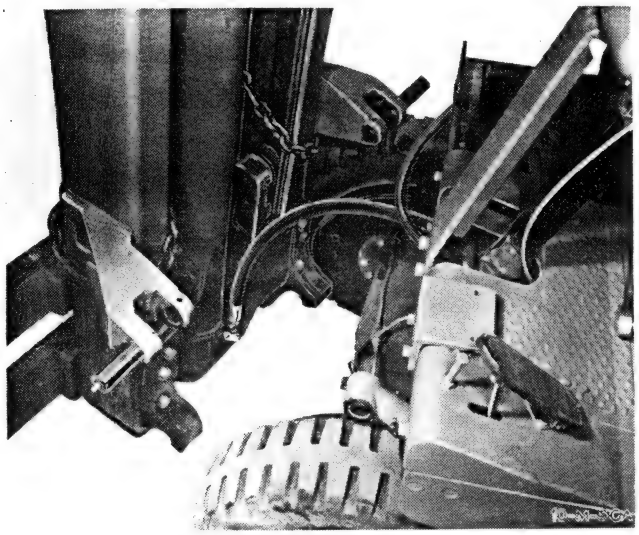


Fig. 114

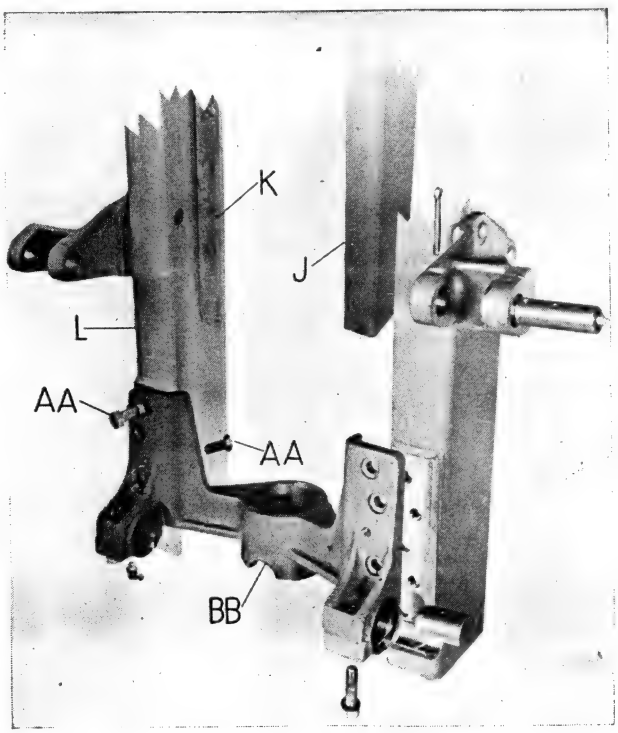


Fig. 115

2. Remove cotter pin and nuts from lift chain anchor pin and remove lift brackets.
3. Lay upright on two saw horses with front side of upright facing down.
4. Remove cotter pin and nuts from other end of chains and remove chains.
5. Take out eight bolts and remove piston head guide.
6. Pull the two inner slides out of outer slides.

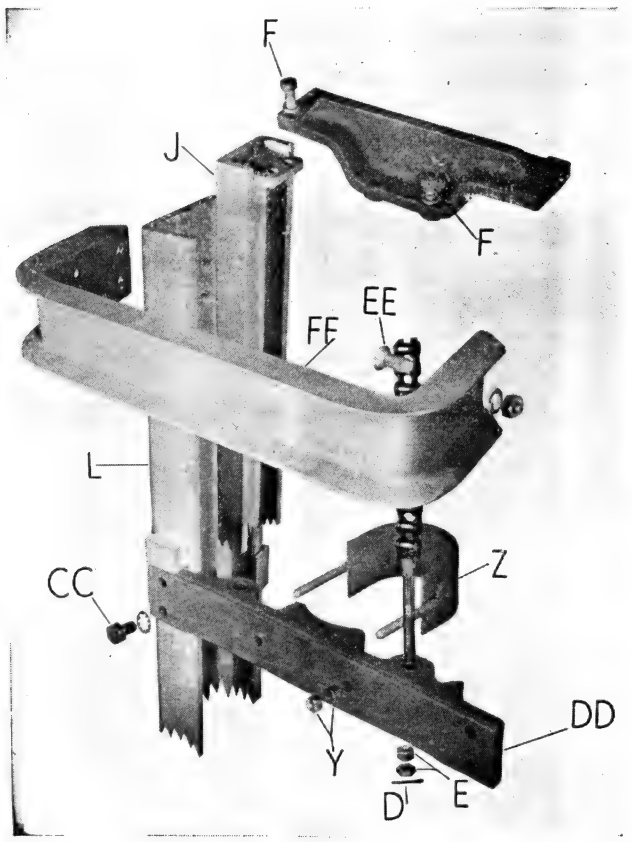


Fig. 116

7. Remove lift hose from bottom of lift cylinder.
8. Remove four nuts and lift cylinder clamp.
9. Remove lift cylinder from upright.
10. Remove upright tie bar, lift cylinder support, and chain anchor bar from outer slides. Upright is now completely disassembled.

Lift Cylinder Disassembly: (See Fig. 117)

1. Loosen set screw (23) and remove piston head (22) from piston rod (15).
   A. Remove two screws (28) from sprocket retaining washer (27).
   B. Remove sprocket (25) and inspect sprocket and bearing (26) for wear. Replace worn or damaged parts.
2. Remove three socket head screws (21) and pull piston rod and oil seal assembly (17) out a few inches.
3. Remove segment ring (20) holding gland assembly (18) in cylinder.
4. Pull piston rod assembly from cylinder (1).
5. Slide oil seal (17), gland (18), and spacer (13) off end of piston rod.
6. Cut and remove lockwire and remove six capscrews (8), piston leather clamp plate (10) and piston leather (11).
7. Using snap ring pliers, expand piston ring (14) enough to slide it off piston.
8. To remove piston (12) from rod, use a drift punch and drive out lock pin. Do not remove piston unless replacement is necessary.

LIFT CYLINDER REASSEMBLY: (See Fig. 117)

1. Replace piston (12) and lock pin on piston rod (15).
2. Install piston ring (14) on piston.
3. Install piston leather (11), clamp plate (10), six capscrews (8), and lockwire. If new leather is required, soak it in SAE 10 oil for thirty minutes before installing.
4. Insert piston rod in cylinder.
   NOTE: If vent pipe hole is not chamfered, place a piece of shim stock over it so the leather will not be cut when it is inserted in cylinder.
5. Slide gland (18) over end of piston rod and into position in the cylinder.
6. Install segment ring (20) to hold gland.
7. Slide oil seal (17) into place and install three socket head screws. Tighten screws alternately to prevent piston rod from binding in oil seal.
8. Install sprockets (25), retaining washer (27) and screws (28) on piston head (22).
9. Place piston head on piston rod and tighten set screw (23).

Upright Reassembly: (See Figs. 115 and 116)

1. Set outer slides on two saw horses and install upright tie bar, lift cylinder support, and chain anchor bar.
2. Set lift cylinder in place in upright.
3. Install lift cylinder clamp and four nuts.
4. Install lift hose at bottom of lift cylinder.

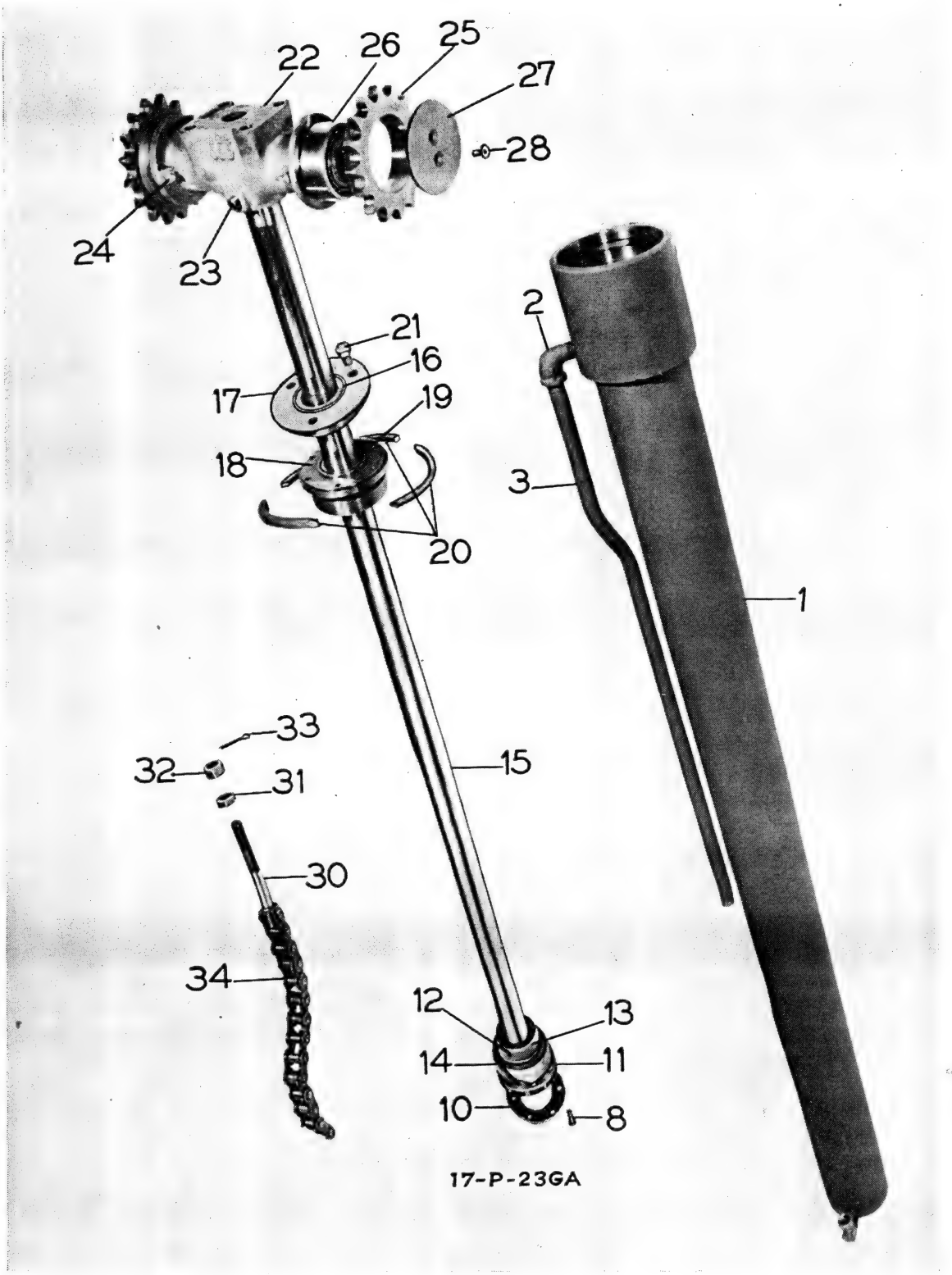

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Fig. 117

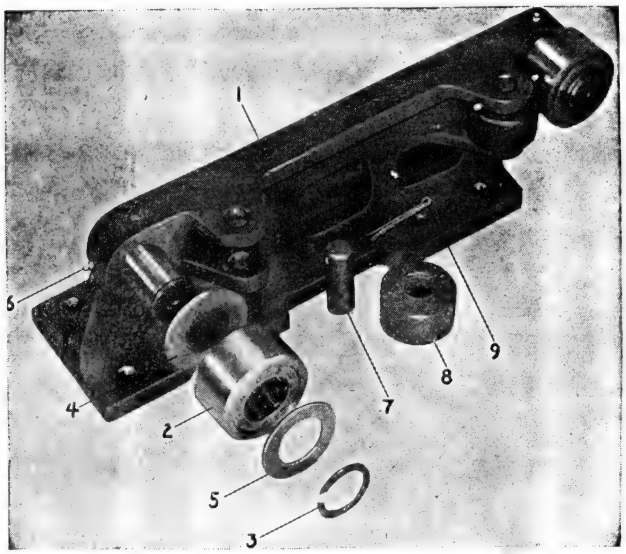


Fig. 118

5. Install inner slides in left and right outer slides.
6. Bolt piston head guide to piston head and inner slides, using eight bolts.
7. Install lift chains, nuts, and cotter pins at chain anchor bar.
8. Slide lift brackets into inner slides and secure them to lift chains with nuts and cotter pins.
9. Place lift chains on sprockets and using a chain hoist, lift upright assembly to a vertical position.
10. Bolt the two finger bars to the lift bracket assemblies with fourteen bolts.

Upright Installation: (See Fig. 114). Maneuver upright into position on frame upright support. Install pins connecting tilt cylinders to upright. Install bearings, bearing cups, and bolts to hold upright assembly to frame upright support. Remove chain hoist and connect hydraulic lines. Install lift finger on finger bars.

Lubricate upright assembly as directed in "Lubrication Instructions" in this manual, and test upright for proper operation.

LIFT BRACKET ASSEMBLIES

Description: The lift bracket assemblies travel up and down the uprights as the load is raised or lowered. They are equipped with rollers for travel and thrust.

Disassembly Procedure:

1. Remove snap rings from roller shafts.
2. Remove rollers, bearings, and washers.
3. Remove large cotter key from thrust roller shaft.
4. Remove shaft and roller.

Cleaning, Inspection and Repair: Clean all parts and inspect for wear or damage. Lubricate bearings before re-installing.

Assembly:

1. Replace shaft and roller.
2. Re-install large cotter key through thrust roller shaft.
3. Re-install washers, bearings and rollers. Re-install snap rings to roller shafts.

Installation Procedure: Place right and left hand bracket into right and left hand upright channels and fasten bumper bars in place.

HYDRAULIC SYSTEM TROUBLE SHOOTING GUIDE

The lifting and tilting of the upright assembly is controlled by the hydraulic system, therefore, aside from mechanical failure, faulty operation of the upright assembly can be traced to the hydraulic system.

1. Upright assembly does not travel to the maximum height. Hydraulic oil level low. Check oil level at the level plug in the sump tank.

2. Upright assembly allows the load on the forks to lower or "drift" when controls are in a neutral position. Possible worn or damaged piston leather, leak in hydraulic system between lift cylinder and hydraulic valve. Oil leaking by worn or damaged hydraulic valve assembly. Check and correct as necessary. The same would apply to the tilt mechanism if the upright assembly allowed the load to tilt forward or "drift" when controls are in a neutral position.

3. Upright assembly fails to respond to lift or tilt controls. Loss of oil pressure, check oil pressure at hydraulic pump, by installing a "T" fitting in pressure line from the hydraulic pump to the hydraulic valve and using a pressure gage that will register 1200 psi or more. If gage does not register or registers low pressure, with engine operating at a fast idle, check pressure relief valve in the hydraulic valve. Check hydraulic pump, check hydraulic valve assembly.

4. Upright leaks oil excessively at top of lift cylinder, possible causes are worn or damaged piston leathers, scored cylinder wall, plugged vent line or worn or damaged piston rod oil seal, repair as necessary.

5. Upright leaks oil excessively at the tilt cylinder piston rods. Loose packing glands, worn packing or scored piston rods, repair as necessary.

6. Upright fork bars uneven when load is lifted. Lift chains out of adjustment, adjust lift chains at chain anchor pins.

NOTES

STEERING GEAR

The steering mechanism comprises steering gear assembly connecting linkage and allied parts of steering axle. The steering gear assembly is connected to steering arm in center of steering axle through the Pitman arm and drag link. Steering axle parts pertinent to steering are covered in "Steering Axle" section of this manual.

Steering gear is recirculating ball type. The worm shaft is mounted in gear housing between two tapered roller bearings. Lower bearing is adjustable toward upper bearing for removing worm shaft end play. Helical cut groove in worm is finished to serve as race for balls between worm and nut. Worm nut fits over worm. Balls are inserted in groove between worm and nut in two separate circuits. Two tubular guides fit into nut and are clamped in place. These guides deflect balls from helical path at end of circuit in nut retaining them to helical part at start of circuit. Thus balls are confined in two separate circuits one on each end of nut, by guides and grooves in worm and nut. The balls are the only contact between worm and nut. When worm is turned, nut moves along worm as with an ordinary screw thread. At the same time balls roll freely between worm and nut. This produces screw action with rolling instead of sliding contact between parts.

The steering gear is mounted to the front cross-member of the frame.

STEERING GEAR REMOVAL

1. Remove U-bolt holding steering column to support bracket.
2. Remove clamp holding directional switch assembly to steering column.
3. Remove and mark horn wires at horn relay.
4. Remove two bolts holding steering column support bracket and dash panel assembly to front cross number and move assembly out of the way.
5. Disconnect drag link at pitman arm. Remove nut, washer, and pitman arm.
6. Remove bolt holding steering gear assembly to steering gear support bracket.
7. Remove steering gear trunnion bolt.
8. Manuever steering gear assembly out of trunnion bracket and away from machine.

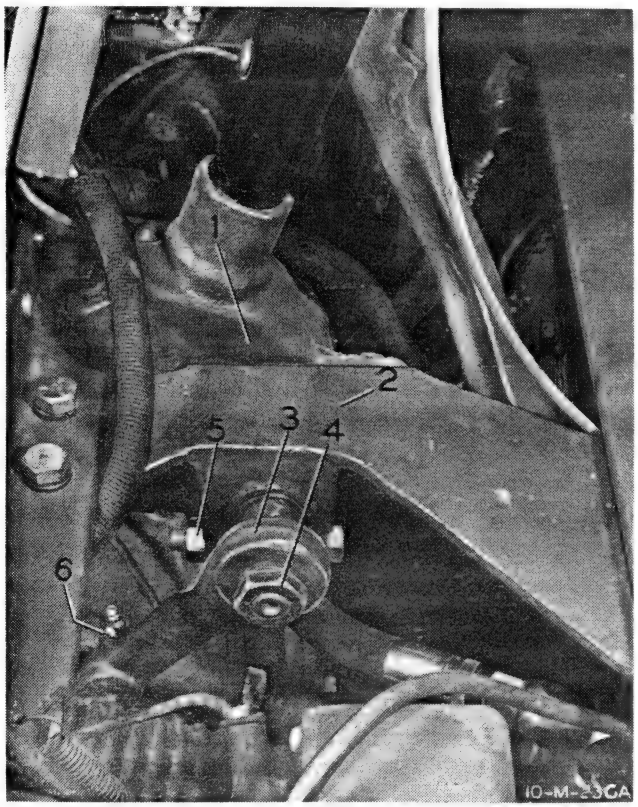


Fig. 119

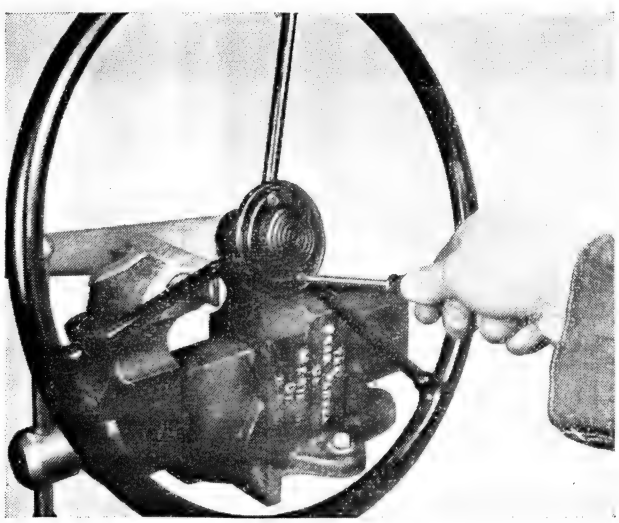


Fig. 120 — Remove Horn Button

Clamp steering gear column jacekt in vise, using brass jaws. Do not clamp so tightly as to damage jacket. Using Phillips type screw driver, remove screws holding horn button retainer. Remove horn button retainer, button, cap, plate, insulator and spring.

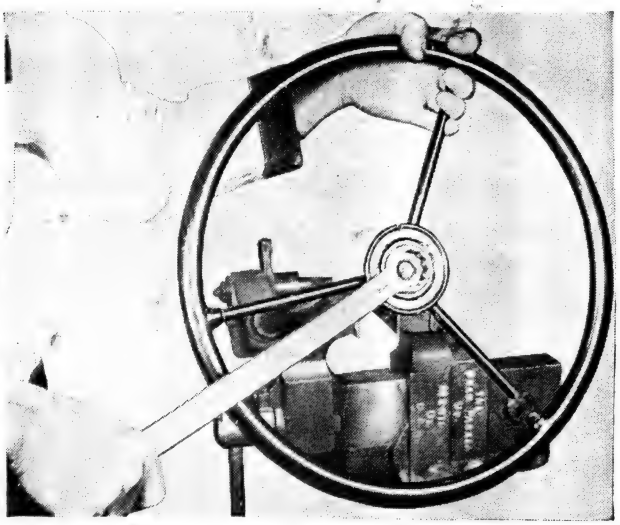


Fig. 121 — Remove Steering Hand Wheel Nut

Remove steering wheel retaining nut from steering shaft.

Remove steering hand wheel by placing soft metal punch against back side of wheel and tapping with hammer.

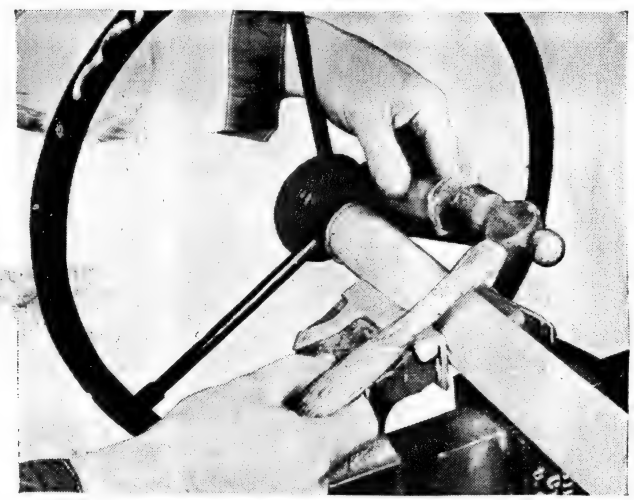


Fig. 122 — Remove Steering Wheel

Loosen locknut (10), figure 78, and turn lash adjuster (11) counterclockwise to relieve load from sector and worm. Remove three capscrews

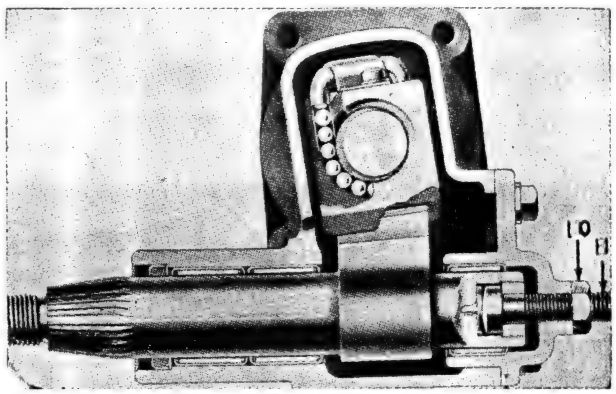


Fig. 123 — Loosen Lash Adjuster

10. Locknut
11. Lash Adjuster

holding side cover to housing. Remove side cover with sector shaft from housing. Remove lash adjustor and side cover plate from sector shaft.

Loosen locknut (13), figure 79, and turn thrust screw (12) to relieve pressure. Remove four capscrews holding bottom end cover to housing. Remove cover and lower end bearing. Remove worm shaft and ball nut assembly from housing.

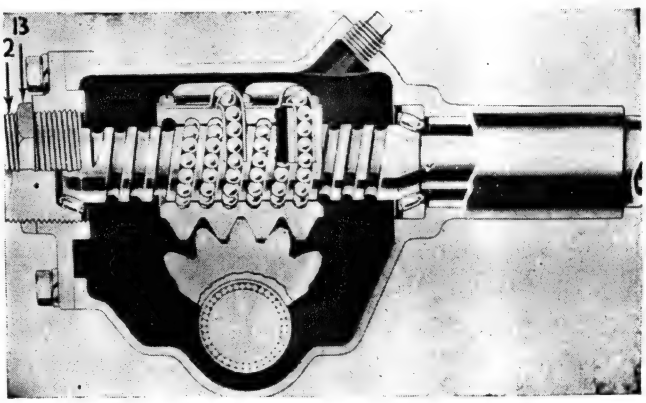


Fig. 124 — Loosen Thrust Adjuster

12. Locknut
13. Thrust Screw

NOTE

Do not attempt to screw worm shaft to either limit as damage will result to ball guides.

HORN WIRE

The horn contact consists of an insulated contact ring which is pressed on worm shaft; a wire soldered to this and extending through a shaft to the top and held in place by a soldered horn button contact also insulated with fibre washers, a

spring and contact brush are located in the oblong hole in the steering column jacket. The brush makes contact with the contact ring. A wire from the horn is connected to the spring and brush and completes the circuit to sound the horn when the horn button is pressed.

DISASSEMBLY OF BALL NUT

Disassembly of the ball nut is only necessary if there is an indication of binding when turning the shaft in the nut. If the movement of the worm shaft is free with no evidence of binding or wear, disassembly of the ball nut will not be necessary.

If wormshaft is to be replaced ball nut must be disassembled for installation to new shaft.

1. Place ball nut flat on clean bench with guide holes at top. Insert worm shaft into nut and align grooves in nut and shaft by locking into ball guide holes.

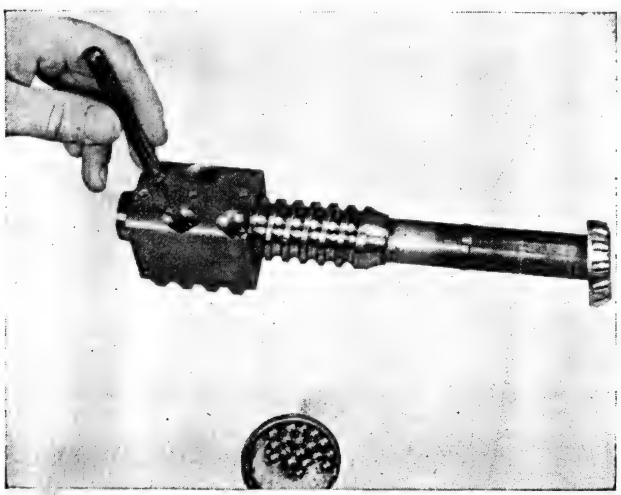


Fig. 125 — Insert Balls into Ball Nut

2. Drop balls into ball nut, one at a time through the guide holes, turning shaft at the same time with slight forward and backward movement. Continue until the circuit is filled with balls. Make certain the circuit is filled by pushing a small punch into guide holes. (See figure 80.)

Position guide halves as shown in figure 76 and place balls in one half-section. Place other half-sections over filled half and plug ends with heavy grease.

Push guide into filled holes of the circuit. If it does not enter easily it can be tapped lightly into place. Fill other ball guide in same manner and position into ball nut. Install ball clamp over ball guides and fasten securely with screws and lockwashers.

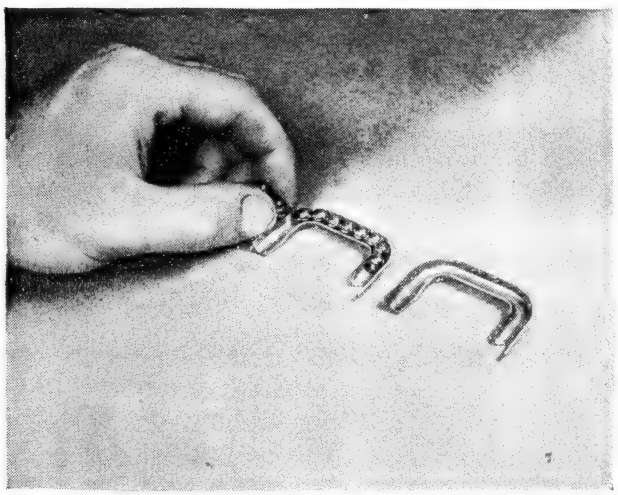


Fig. 126 — Place Balls into Guide Half

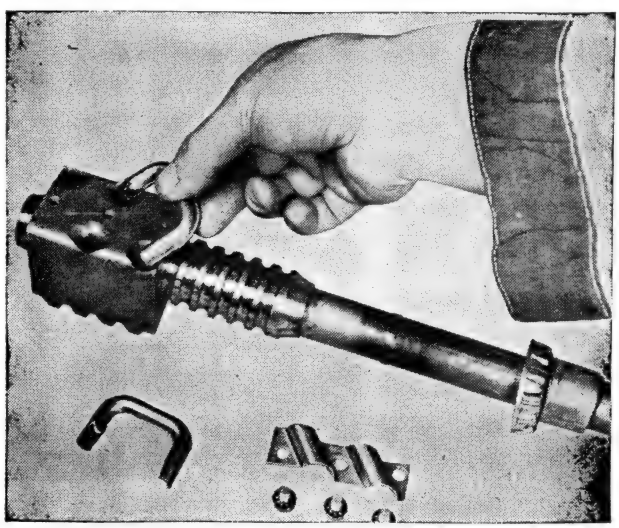


Fig. 127 — Place Filler Guide into Nut

STEERING GEAR ASSEMBLY

Place upper worm thrust bearing over worm shaft and install worm shaft and ball nut in housing. Install lower thrust bearings, gasket and cover to housing. Install hand steering wheel to shaft and secure with lockwasher and nut. Install horn spring, insulator, plate, cap and retainer. Fill gear housing to level plug with SAE 90 oil.

To adjust thrust bearings, turn thrust bearing adjuster (12), figure 79, clockwise until there is no perceptible end play in shaft. Check pull at

wheel rim. This pull can be measured by attaching a spring scale to the rim of the wheel with a piece of cord, then pulling on the spring scale to turn the wheel. The line of the scale should be kept tangent to the rim of the wheel. The proper value of the pull at the wheel rim under these conditions will be 1 to 1½ lbs. Set up locknut (13) figure 79, and recheck pull, as it must be within the specified limits after the locknut is set up.

Assemble lash adjustor to slot in sector and install sector shaft, gasket and side cover. Sector should be centered to worm as shown in figure 79. To adjust lash adjustor first turn steering wheel gently from one stop all the way to the other, carefully counting the total number of turns. Then turn wheel back exactly half way to center position. Mark wheel at top or bottom center with piece of tape. Turn lash adjustor (11), figure 78, clockwise to take out all lash in gear teeth. Check pull at wheel rim as before, taking the highest reading of the spring scale as the wheel is turned through center position. Proper value of pull will be 2 to 2½ lbs. Set up locknut (10) figure 78 and recheck pull as it must be within the specified limits after the lock nut is set up.

STEERING GEAR INSTALLATION
(See Fig. 119)

1. Position steering gear in trunnion bracket.
2. Install trunnion bolt and nut.
3. Install steering gear to support bracket bolt.
4. Install pitman arm, washer, and nut.
5. Connect drag link at pitman arm.
6. Install steering column support bracket and dash panel assembly.
7. Connect horn wires at horn relay.
8. Clamp directional master switch assembly to steering column.
9. Install steering column to support bracket U-bolt and nuts.

STEERING GEAR ADJUSTMENT

Correct adjustment of steering gear is very important. While there are but two adjustments to be made, the following procedure must be followed step by step.

1. Disconnect steering drag link.

2. Loosen column "U" bolt making sure there is no bind to anchorage.

3. Loosen locknut (10) figure 78, and turn lash adjustor (11) a few turns in counterclockwise direction. This removes from thrust bearings the load imposed by close meshing of worm and sector teeth. Turn steering wheel gently in one direction until stopped by gear, then back away about one turn. Do not turn steering wheel hand against stops when gear is disconnected, damage to ball guides may result. Measure the pull at the rim of the wheel which is required to keep the wheel in motion. This pull can be measured by attaching a spring scale to the rim of the wheel with a piece of cord, then pulling on the spring scale to turn the wheel. The line of the scale should be kept tangent to the rim of the wheel. The proper value of the pull at the wheel rim under these conditions will be 1 to 1½ lbs. on thrust bearings. If the actual value does not lie between the limits specified, adjustment of thrust bearings is necessary. To adjust thrust bearings, loosen lock nut (13), figure 79 and turn thrust bearing adjustor (12) clockwise until there is no perceptible end play in worm. Check pull at wheel rim as above readjusting if necessary to obtain proper pull. Set up lock nut (13) and recheck pull as it must be within the limits after the lock nut is set up. To continue the adjustment procedure, next make sure that it will not be necessary to spring steering column to fasten "U" bolt. It may be necessary to loosen gear at frame mounting and shift gear slightly or to do same shimming at frame-mounting or at "U" bolt. Mounting bolts should, of course, be tightened securely after this is done. Tighten column at "U" bolt and recheck pull at wheel rim. If this has increased materially there is still a spring condition in the column which must be corrected before proceeding.

After proper adjustment of thrust bearings is obtained, and all mounting bolts securely tightened, adjust lash adjustor (11), figure 78. First turn steering wheel gently from arm stop all the way to the other, carefully counting the total number of turns. Then turn wheel back exactly half way to center position. Mark wheel at top or bottom center with piece of tape. Turn lash adjustor (11) clockwise to take out all lash in gear teeth and tighten lock nut (10). Check pull at wheel rim as before, taking the highest read-

ing of the spring scale as the wheel is turned through center position. Proper value of pull will be 2 to 2½ lbs. pull over center. Readjust if necessary to obtain proper pull. Before connecting drag link to Pitman arm position steering wheels perfectly parallel with machine and with steering gear exactly in center, install drag link. If this operation changes the position of the steering gear or steering wheels then steering should be re-centralized by removing Pitman arm from sector shaft. Reposition steering gear and steering wheels and reinstall Pitman arm to sector shaft. After steering is centralized wheel alignment should be checked to make sure both steering wheels are parallel with no toe-in or toe out. If wheels are not parallel this can be corrected by loosening lock nuts and clamp bolts on tie rod ends and turning tie rods as necessary to correct, making sure steering gear is still in center position after adjustment is made. After steering is centralized and wheel alignment check it is necessary to check steering spindle stops on the steering axle to make sure spindles contact the stops before the steering gear "bottoms" or reaches its full travel. When spindle stops are properly adjusted steering gear will lack approximately ½ turn of the wheel of completing its full travel either way. If these are not properly set allowing the steering gear to "bottom" or reach its full travel before spindles contact the stops it will cause serious damage to the steering gear.

DRAG LINK INSTALLATION

Turn hand sheel of steering gear slowly from one stop to the other, counting the turns. Mark wheel with piece of tape or string and turn back half the number of total turns. Place pitman arm in vertical position so that it will have the same amount of forward and backward throw. Place steering wheels in position for travel straight ahead. Place drag link on ball studs of steering arm and pitman arm and adjust socket of threaded end of drag line so that socket opening lines up with ball studs. Place ball seats in sockets and turn in adjusting plugs until a little tension is obtained but there is still freedom enough for easy steering.

STEERING GEAR TROUBLE SHOOTING GUIDE

(Refer to Steering Trouble Shooting in Axle Steering Section)

STEERING GEAR SERVICE REFERENCE

NUMBER	DATE	SUBJECT	CHANGES

NOTES

TIRES AND WHEELS

TIRE MAINTENANCE

1. To obtain maximum wear and trouble-free service from the drive and steering wheel tires, they should be inspected every 40 operating hours, and all foreign matter that might be imbedded in the tires should be removed.

2. If due to operational reasons it is found that one drive tire wears more than the other, it is advisable to change wheels and tires from one side to the other to obtain maximum wear.

DRIVE WHEEL AND TIRE REMOVAL

1. To remove drive wheel and tire, tilt the upright back toward the driver as far as it will go, place a two-inch by four-inch block under the bottom of the upright channel and tilt the upright forward until the drive wheels just clear the floor.

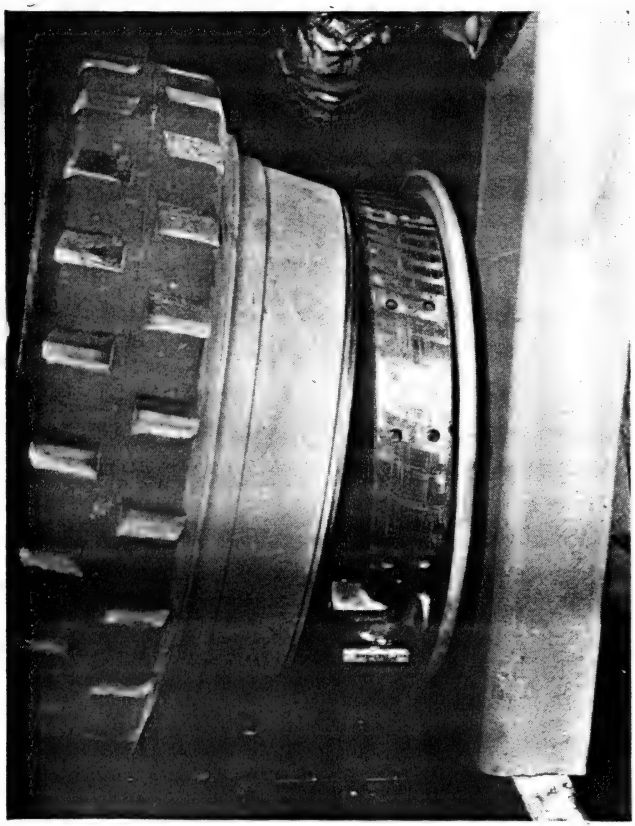


Fig. 128

2. Back off brake adjustment to full release position.

3. Remove hub cap capscrews and remove hub cap.

4. Remove cotter pin from wheel bearing adjusting nut, then, with proper wrench, remove adjusting nut.

5. Remove thrust washer and outer bearing cone, then remove wheel from assembly.

DRIVE WHEEL AND TIRE INSTALLATION

1. Roll wheel into mounting position.

2. Tilt upper portion of break drum over dust shield.

3. Tilt upright forward until wheel reaches perpendicular position on floor.

4. Tilt upright back until upper portion of drum can be pushed over breade shoe.

5. Tilt upright forward until wheel squares itself and revolve wheel to line up spur and ring gear.

6. Push wheel on and install bearing and thrust washer.

7. Install wheel nut and tighten. Then back off one castellation and insert cotter pin.

8. Replace hub cap and cap screws.

9. Readjust brake cams for proper brake adjustments.

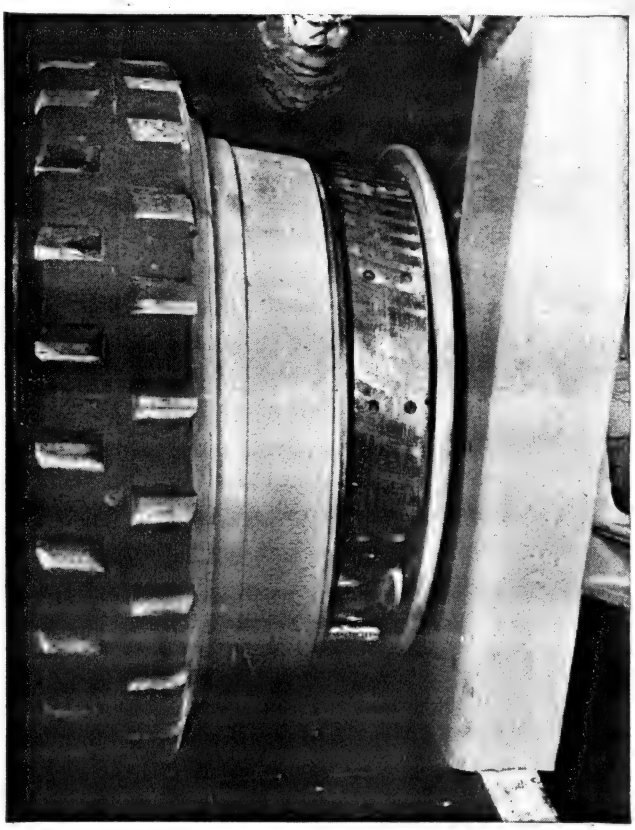


Fig. 129

STEERING WHEEL AND TIRE REMOVAL

1. Remove steering wheels by raising up end of machine with a hoist or hydraulic jack.
2. As a precaution, put blocks under the axle at this time to support the weight.
3. Remove four cap screws holding hub cap to wheel and remove hub cap, cotter pin, nut, and plain washer.
4. Shake wheel on spindle to loosen outer bearing, and slide wheel off spindle.

NOTE: Steering wheel bearings are tapered roller bearings designed for end thrust and roll. The cups are a press fit in the wheel but can be driven out with a hammer and drift punch.

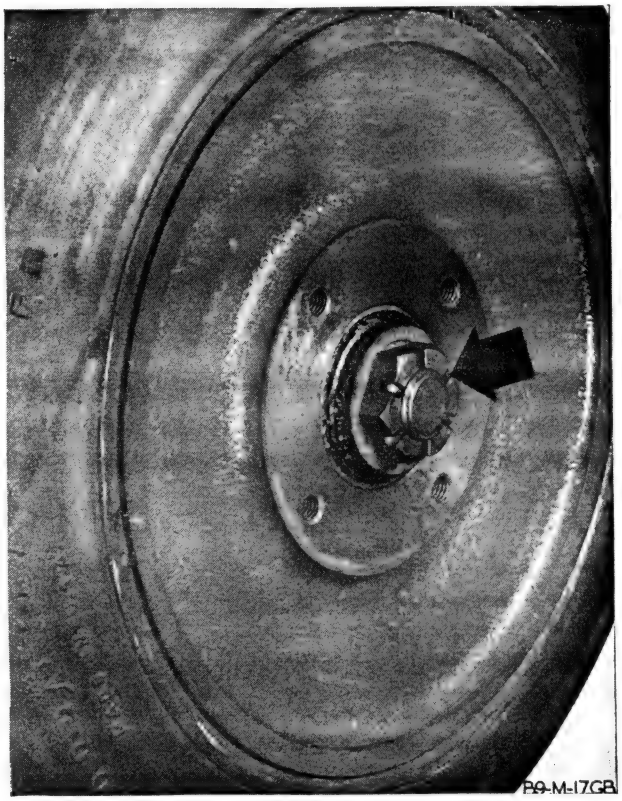


Fig. 130

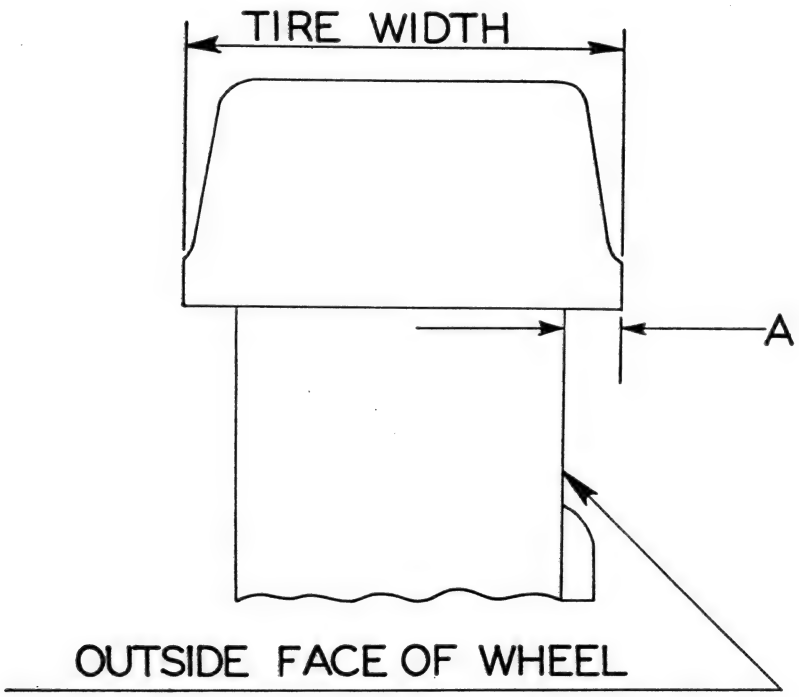
STEERING WHEEL AND TIRE INSTALLATION

1. To install steering wheel, put inner bearing on spindle and slide wheel on spindle.
2. Slide outer bearing on spindle.
3. Install washer and nut.
4. Tighten nut, then back off on castellation and insert cotter pin.
5. Install hub cap with four cap screws.
6. Remove blocking and lower machine to floor.

TIRE PRESSING INFORMATION

The cushion type tires used on this machine are pressed onto the wheels with a hydraulic press under a pressure of about 50 tons. Worn tires must also be removed with a hydraulic press.
DATA: Refer to Fig. 131.

Tire	Outside Diameter	Width	Inside Diameter	A
Drive	21″	7″	15″	3/8″
Steering	15½″	6″	10″	¾″



10-M-30CA

Fig. 131

The relative position of the tires on the wheel, when properly installed, will conform to dimension "A" which is shown in Fig. 131., and listed under "Data."

NOTES

TRANSMISSION

DESCRIPTION:

The transmission is a two speed unit furnishing power as high and low speed from a shift lever. Since the reverse gear and forward gear are connected to a dynatork drive unit, the means of shifting from reverse to forward is accomplished by proper positioning of the dynatork forward and reverse lever.

To place the transmission in the forward drive it is necessary to put the shift lever in low or high range position and shift the direction control lever to the forward position. The rotation of the flywheel is then transferred through the dynatork unit to the main shaft and rotating the main shaft gears. The main shaft gears are driving the low and high range gears on the pinion shaft. With the speed shift lever in low, the shift hub engages the low gear to drive the pinion shaft through a splined coupling. The rotation of the pinion shaft will, through the pinion shaft gear, rotate the quill shaft sun gear. The rotation of the quill shaft is transmitted to the drive axle. The low and high range gears float on the pinion shaft on needle bearings and are engaged through the shift hub to the pinion shaft.

When the forward-reverse lever is moved to the reverse position, the reverse dynatork rotor and reverse hub are driven in the same direction as the crankshaft. The reverse gear on the reverse hub will rotate the reverse idler gear. The idler gear in turn will rotate the pinion shaft reverse gear. If the shift lever is in low range, the drive will go from the pinion shaft reverse gear through the main shaft gears to the low range gear on the pinion shaft. The pinion shaft will then be driven in low and in a reverse direction. The rotation of the pinion shaft gear will rotate the quill shaft. If the shift lever is in high range the pinion shaft reverse gear will be coupled directly to the pinion shaft by the shifter hub and the pinion shaft will be driven directly from the pinion shaft reverse gear.

TRANSMISSION REMOVAL
(See Fig. 132)

With upright, floor plates, and steering gear assembly removed, drain drive axle and transmission assembly, and proceed as follows:

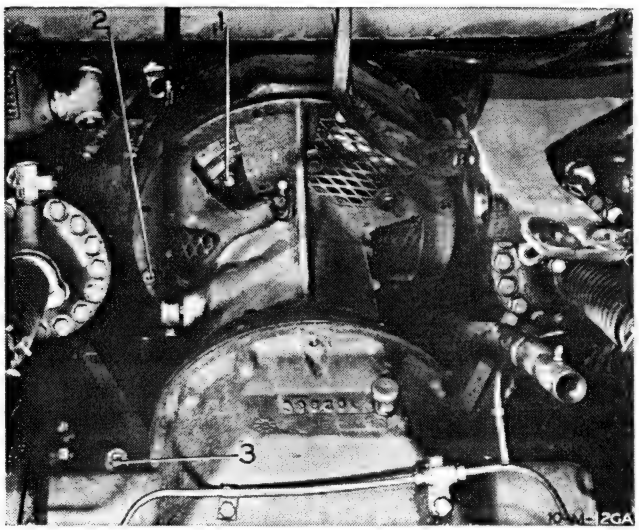


Fig. 132

1. Place blocking under frame behind drive wheels.
2. Place blocking under flywheel housing.
3. REMOVE COUNTERWEIGHT OR BLOCK IT SECURELY.
4. Disconnect vent hose at sump tank.
5. Remove reverse tilt cross hose.
6. Remove battery and instrument panel ground wires at transmission case.
7. Disconnect brake line at Tee.
8. Remove vent screen to gain access to collector ring.
9. Remove six bolts holding collector ring to flywheel by rotating flywheel.
10. Remove twelve bolts holding transmission case to flywheel housing.
11. Using a chain hoist, support weight of drive axle, and transmission assembly.
12. Remove four bolts and nuts holding drive axle to frame.
13. Maneuver assembly away from machine.
14. Block assembly in a suitable working position, remove thirteen bolts holding trans-

mission case to drive axle and lift transmission assembly from drive axle.

TRANSMISSION DISASSEMBLY (See Fig. 137)

Place transmission in a suitable working position and proceed as follows:

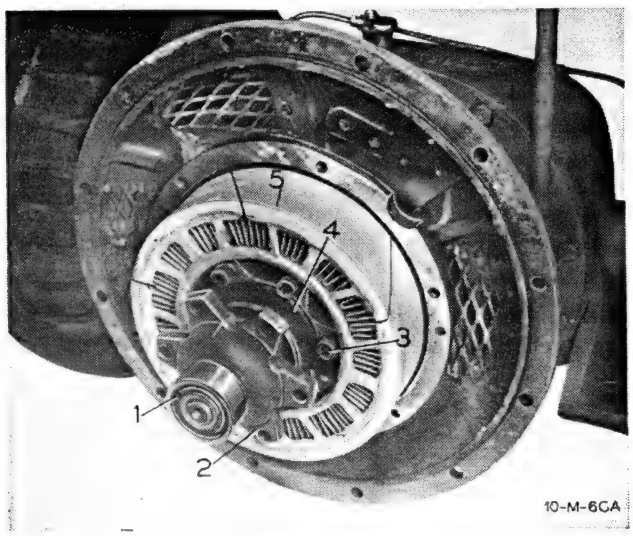


Fig. 133

1. Remove flywheel pilot bearing (40) from mainshaft.
2. Remove six socket head bolts and remove mainshaft rotor from mainshaft hub. Repeat this operation to remove rotor from quill shaft.

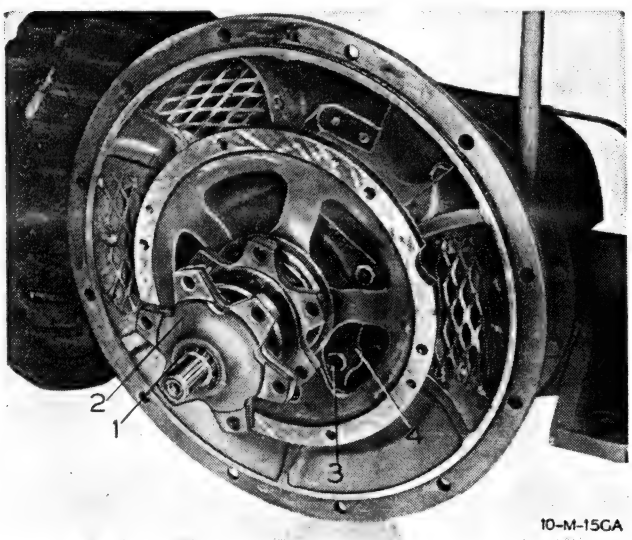


Fig. 134

3. Remove mainshaft hub retaining ring (41) and pull hub (42) from mainshaft (28).

MAINSHAFT AND QUILL SHAFT REMOVAL (See Fig. 135)

1. Remove six bolts (38) from mainshaft front bearing caps (35).
2. Take out eight bolts (23) and remove inspection plate (21) and gasket from transmission case.

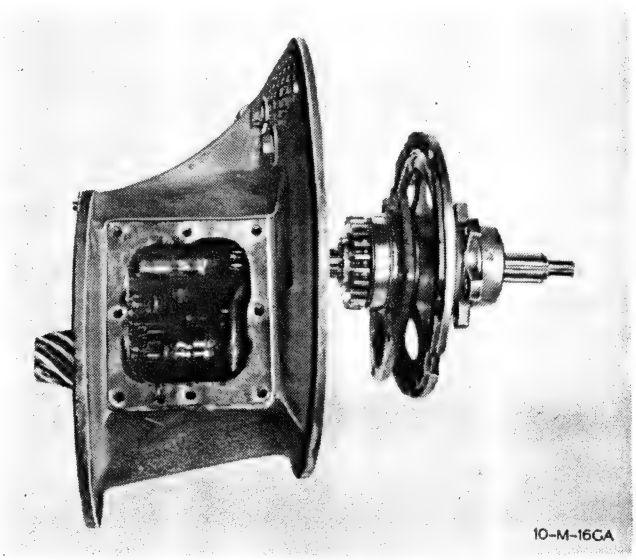


Fig. 135

3. Remove mainshaft rear nut (3). Quill shaft and mainshaft assembly can now be pulled from transmission case. See Fig. 135.
4. Reach into transmission case and lift out mainshaft high range gear (12), mainshaft gear spacer (11), and mainshaft low range gear (10).
5. Remove mainshaft rear bearing retaining ring and mainshaft rear bearing (4) from transmission case (5).

PINION SHAFT REMOVAL

1. Remove pinion shaft nut (48), and pinion shaft bearing spacer shims.
2. Pull pinion shaft assembly (1) from rear of transmission case.
3. Reach into transmission case and lift out:
   A. Pinion shaft front bearing spacer (18)
   B. Pinion shaft high and reverse gear (16)
   C. Pinion shaft high and reverse gear bearing sleeve (17)

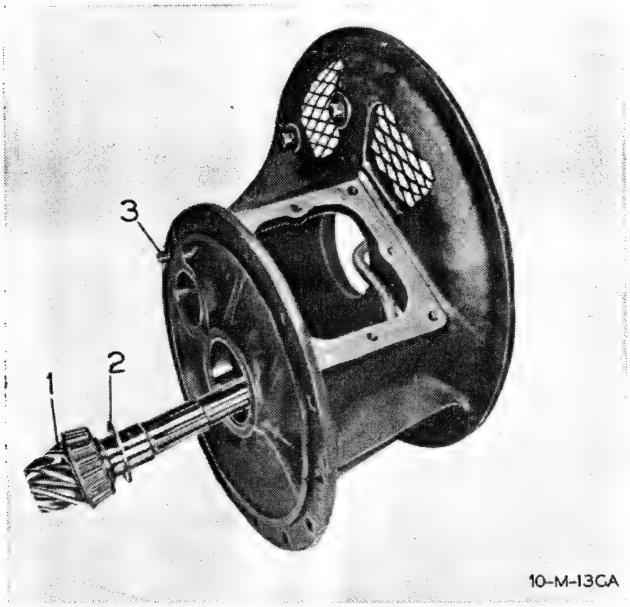


Fig. 136

D. Pinion shaft high and low shift hub sleeve
E. Pinion shaft high and low shift hub (15)
F. Pinion shaft low range gear (14)

4. Remove pinion shaft front bearing from transmission case. Ref. 49, Fig. 137.

REVERSE IDLER SHAFT

The reverse idler shaft extends into the transmission case and supports the shift forks.

1. Force the reverse idler shaft (50) forward until reverse idler shaft key can be removed from the forward end of the shaft.
2. Turn the shaft one-quarter turn to free shift fork poppet ball (27) on the shaft.
3. Remove the reverse idler shaft (50), shift fork (24), shift fork poppet ball (27), shift fork poppet spring (26) and reverse idler gear assembly (25).

QUILL SHAFT DISASSEMBLY

1. Remove retaining ring, mainshaft reverse gear, and mainshaft front bearing oil slinger.
2. Using a gear puller, remove mainshaft front bearing and bearing cap. Fig. 138.
3. With gear puller, remove mainshaft outboard support. Fig. 139.
4. Using gear puller, remove mainshaft outboard support bearing spacer and mainshaft outboard support bearing. Fig. 140.
5. Remove retaining ring and quill shaft rotor hub bearing from quill shaft. Fig. 141.
6. Remove quill shaft oil seal from quill shaft rotor hub.

MAINTENANCE AND INSPECTION:

Normally the only maintenance required on the transmission is to check the oil level at each forty hours inspection period. Keep the transmission filled to the level of the filler plug with SAE-90 gear oil for temperatures above 0°F and SAE-80 gear oil for temperatures below 0°F. After every one thousand hours or six months of operation, remove the drain plug in the main case and rear case. Drain the transmission completely. Fill with flushing oil and operate for five minutes. Drain out the flushing oil and refill the transmission case with the proper weight of gear oil. Keep the breather cap free from dirt and lint and clean at each forty hours inspection period.

The transmission will give long and satisfactory service if properly cared for and lubricated at regular intervals. However, normal wear of the unit and/or a breakdown will at times call for disassembly and repair. Therefore, complete disassembly and reassembly is included. Remember that the transmission is a precision unit and all clearances and tolerances should be set properly when reassembling the unit. Also care must be exercised in handling, cleaning, and working on the bearings. **Never** hit, pound, drive, or use a hammer on any bearing. Always clean bearings in a clean solvent, individually, never with any other part, tool, or bearing.

The following procedures are outlined for use when the transmission has been disassembled for repair or overhaul.

Thoroughly clean all bearings in clean solvent. Be sure the bearings are free of all oil, dirt, grit and grease. Use two cleaning solutions if necessary. Blow the bearing dry with filtered compressed air. (NOTE: Do not allow the bearing to spin while drying. Lay in a safe place and keep covered with a cloth. Do not handle the bearing more than is absolutely necessary after cleaning. Cover the bearing with a clean cloth when handling.) Roll the bearing by hand, checking for

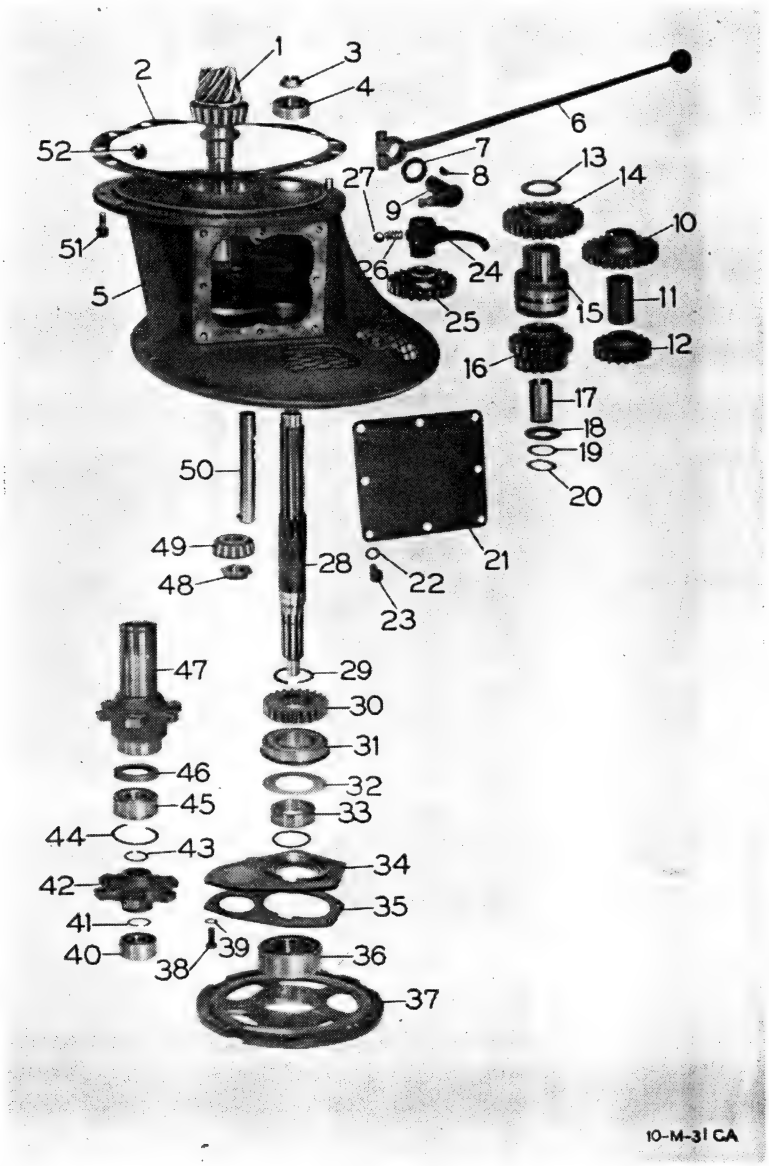


Fig. 137

rough spots, dented race, or bad balls. Also check for excessive play of the balls or rollers between the races. Replace the bearings if there is excessive wear, rough, or high spots are found.

Clean all gears in clean solvent removing all gum formations, oil, and dirt. Blow the gears dry with filtered compressed air. Inspect the gears thoroughly. Look for chipped, broken, worn, or galled gear teeth. Inspect the splines of the gears for fit on their respective shafts, chipping, burrs, on face of splines, or excessive wear. Remove small burrs with a fine stone removing only the raised edge of the burr. Inspect the surface of gears for radial cracks. Replace any gear that is badly damaged.

Clean the pinion shaft, main shaft, shift rail shaft, and quill shaft in clean solvent. Blow dry with filtered compressed air. Clean all matching surfaces with steel wool to remove any gasket or gasket sealer that may adhere to case or covers. Inspect the case and covers for cracks. Inspect the case and covers for cracks, breaks, or damaged bearing surfaces. Replace any part that is broken or cracked.

Always use new gaskets and oil seals when reassembling the transmission to prevent any pos-

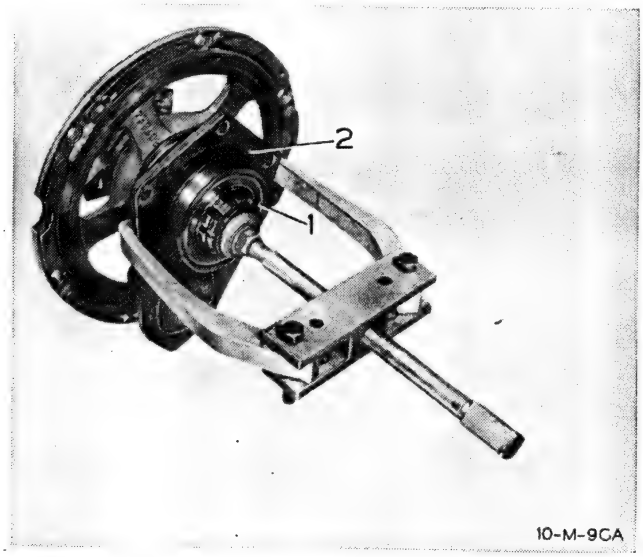


Fig. 138

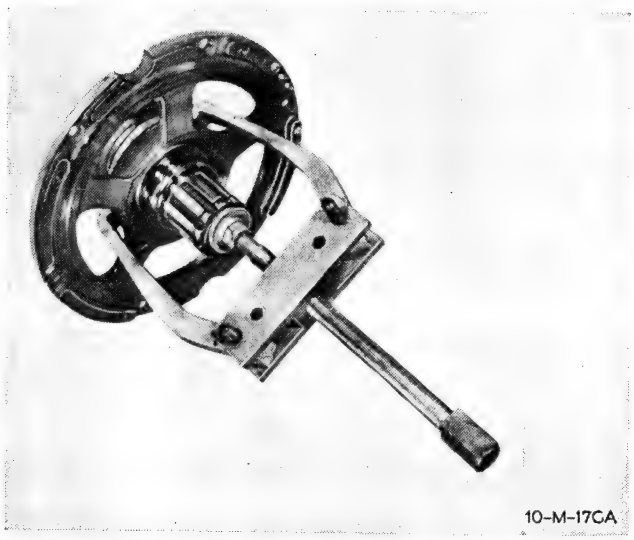


Fig. 139

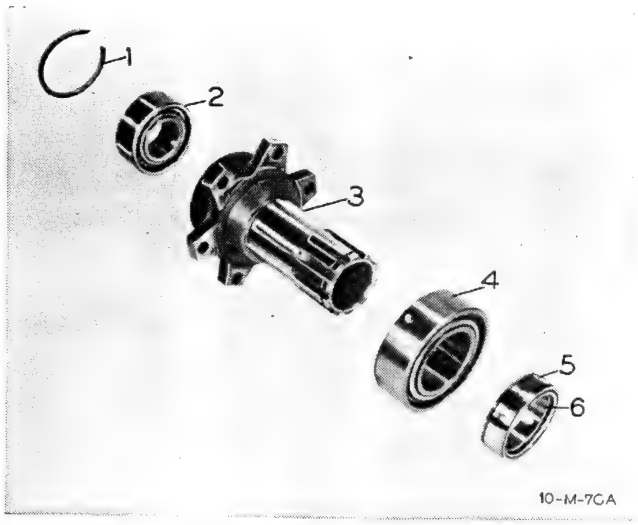


Fig. 140

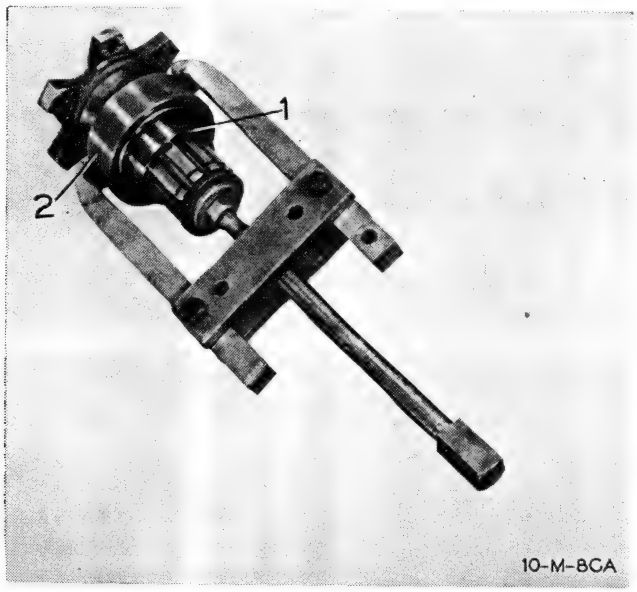


Fig. 141

sibility of oil leaks. Seal all gaskets with a thin coating of gasket sealing compound on both faces of the gaskets.

It is always advisable to use new snap rings and cotter keys when reassembling the transmission to prevent the possibility of any part coming loose.

The pinion shaft lock nut and mainshaft retaining nut, should also be replaced when the transmission has been disassembled.

TRANSMISSION REASSEMBLY
(See Fig. 137)

In the following proccdure on reassembly of the transmission, it will be necessary to use an arbor press to install certain parts. It is also recommended that new gaskets and oil seals be used. Gaskets should be sealed with suitable gasket sealer.

QUILL SHAFT REASSEMBLY
(See Figs. 138, 139, 140, 141)

1. Install oil seal, rotor hub bearing, and retaining ring, in quill shaft rotor hub.
2. Using an arbor press, install in order:
   A. Mainshaft outboard support bearing.
   B. Mainshaft outboard support bearing spacer.

C. Mainshaft outboard support.

D. Mainshaft front bearing cap.

E. Mainshaft front bearing.

3. Install mainshaft front bearing oil slinger, mainshaft reverse gear, and retaining ring.

REVERSE IDLER SHAFT INSTALLATION (See Fig. 137)

1. Install shift lever arm (24) in transmission case.
2. Position reverse idler gear assembly (25) in the transmission case and insert the reverse idler shaft (50) through the reverse idler gear.
3. With reverse idler gear shaft turned ¼ turn from normal position, install the shift fork (24) with the shift fork poppet spring (26) and ball (27) in place.
4. Press the reverse idler shaft (50) through the shift fork.
5. Install reverse idler shaft key (8).
6. Turn shaft to its normal position and press into place.

PINION SHAFT INSTALLATION
(See Fig. 136 for Procedure)
(See Fig. 137 for References)

1. Start the pinion shaft assembly into the transmission case and install in order:
   A. Pinion shaft low range gear (14).
   B. Pinion shaft high and low hub sleeve.
   C. Pinion shaft high and low shift hub (15).
   D. Pinion shaft high and reverse gear bearing sleeve (17).
   E. Pinion shaft high and reverse gear (16).
   F. Pinion shaft front bearing spacer (18).
2. Install shims required for eight to ten inch pounds tension on pinion bearings after pinion shaft nut is tightened.
3. Install pinion shaft front bearing (49) and bearing nut (48).
4. After proper pinion bearing tension adjustment is made, stake bearing nut securely.

MAINSHAFT AND QUILL SHAFT INSTALLATION (See Fig. 135)
(See Fig. 137 for References)

1. Install new gasket (35) on mainshaft front bearing cap (34).
2. Insert mainshaft (25) into quill shaft (47) assembly.
3. Start mainshaft into transmission case and install in order:
   A. Mainshaft high range gear (12).
   B. Mainshaft gear spacer (11).
   C. Mainshaft low range gear (10).
4. Install mainshaft rear bearing (4) and retaining ring in transmission case.
5. Press mainshaft into place and secure with the mainshaft rear nut (3).
6. Stake mainshaft rear nut securely.
7. Position gasket and bolt mainshaft front bearing cap (34) to transmission case (5) with six capscrews.
8. Install mainshaft rotor hub (42) and retaining ring (41).
9. Install flywheel pilot bearing (40) on mainshaft (28).

Install new gasket and bolt inspection plate (21) to transmission case.

Install rotors on rotor hubs. See Figs. 133 and 134.

TRANSMISSION INSTALLATION

1. Install new gasket and bolt transmission assembly to drive axle.
2. Attach chain hoist to assembly and maneuver into position on machine.
3. Bolt drive axle to frame with four bolts and nuts.
4. Bolt transmission case to flywheel housing with twelve bolts. See Fig. 132.
5. Bolt collector ring to flywheel with six bolts.
6. Install vent screen on transmission case.
7. Connect brake line at Tee.
8. Fasten battery and instrument panel ground wires at transmission case.
9. Install reverse tilt cross hose.
10. Connect vent hose at sump tank.
11. Remove blocking from frame, flywheel housing, and counterweight.
12. Fill drive axle with proper lubricant. See "Lubrication Instructions."

TRANSMISSION TROUBLE SHOOTING GUIDE

Symptoms indicating trouble in transmission is sometimes caused by another assembly, such as the axle. Before removing the transmission to locate the trouble always check the possibility that trouble may exist in other closely associated units.

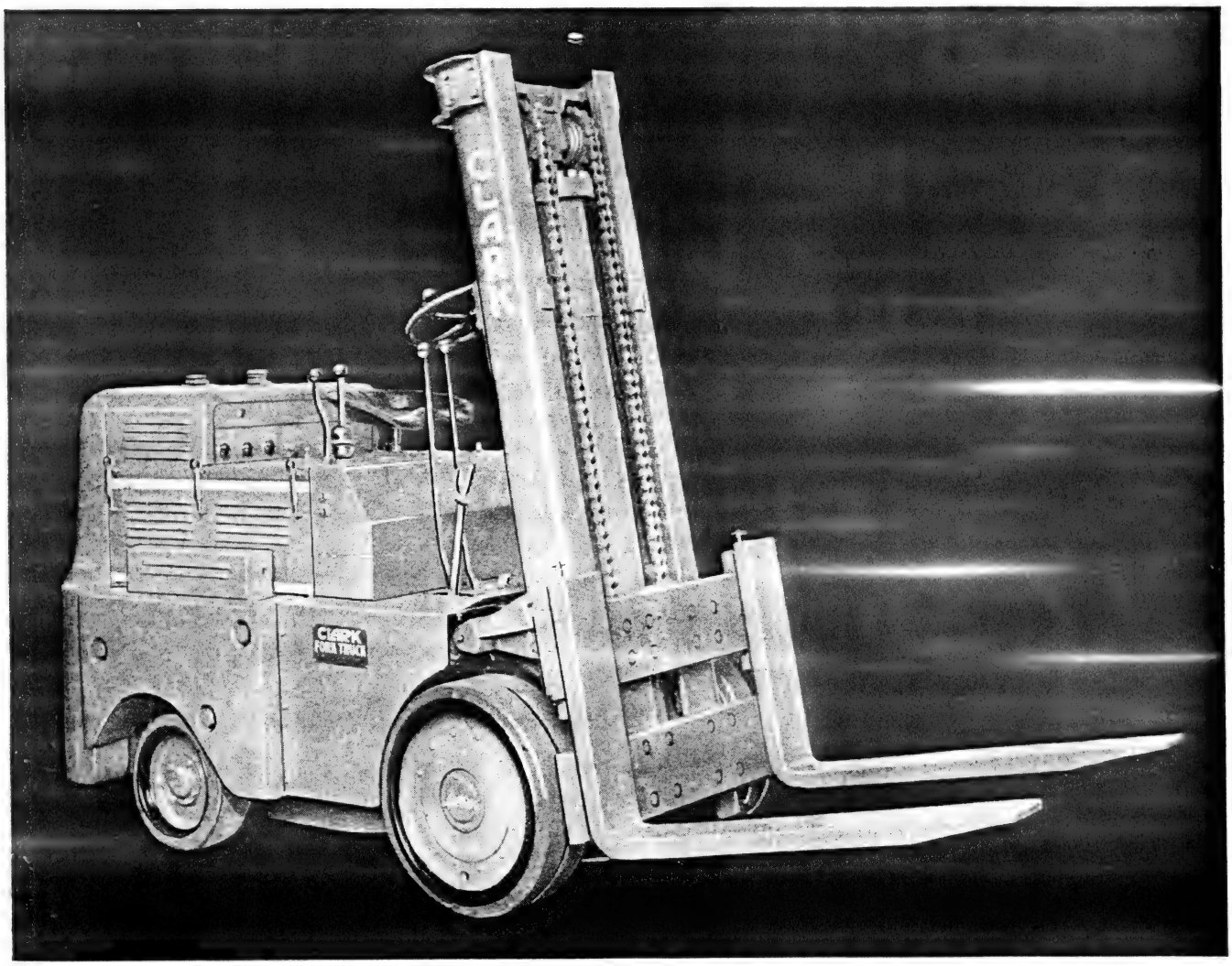
NOISY

1. Before beginning actual operations to eliminate noise attributed to transmission, make sure that the noise is not coming from another unit in vehicle, also bear in mind that a certain amount of transmission gear "noise" is normal except when the unit is in direct drive.
2. Worn or damaged parts. Replace parts as necessary or overhaul the assembly.
3. Improper or insufficient lubricant. Change or add lubricant as directed in "Lubrication" section.
4. Misalignment of transmission with flywheel housing. Tighten transmission mounting bolts if not tight, otherwise determine and correct cause of misalignment.

LUBRICANT LEAKS

1. Lubricant level too high. Keep level at the filler plug level.
2. Worn oil seal. Replace oil seal assembly.
3. Main drive gear bearing retainer capscrew loose. Tighten screws.
4. Cover plate screws loose or gaskets defective. Tighten screws or replace gaskets.
5. Bearing retainer caps loose or gaskets defective. Tighten screws or replace gaskets.
6. Transmission case cracked or broken. Replace transmission case.

NOTES



CLARK

"UTILITRUC" FORK TRUCK

AND

CLEVELAND "6000"

MANUFACTURED UNDER DESIGNS LICENSED
FROM

CLARK EQUIPMENT COMPANY
INDUSTRIAL TRUCK DIVISION

CONTENTS—Cont'd

SERVICE POLICY AND WARRANTY

We warrant each Clark machine manufactured by us to be free from defects in material and workmanship under normal use and service, our obligation under this warranty being limited to making good at our factory any part or parts thereof which shall, within ninety days after delivery to purchaser, be returned to us with transportation charges prepaid, and which our examination shall disclose to our satisfaction to have been defective.

We make no warranty whatever in respect to tires, ignition apparatus, horn, starting devices, generator, batteries or other trade accessories, inasmuch as they are usually warranted separately by their respective manufacturers.

IMPROVEMENTS

The Clark Tructractor is constantly striving to improve its machine. Changes in design and improvements will be made whenever the manufacturer believes the efficiency of the machine will be improved thereby, but without incurring any obligations to incorporate such improvements in any machine which has been shipped or is in service.

HOW TO ORDER PARTS

In order to avoid delay, unnecessary correspondence, and have your orders filled correctly and promptly and at the least possible expense, it is absolutely necessary that you cooperate with us in the following:

WHEN ORDERING PARTS SPECIFY

How we shall ship.
Where we shall ship.
How many of each part you want.
Part Number.
Name of part.

SERIAL NUMBER OF MACHINE

When parts are not included in parts list, give full description and SERIAL NUMBER of machine.

Order through nearest parts station when possible.

TERMS

All prices are net F. O. B. factory, Battle Creek, Michigan.

Orders from individuals not accompanied by cash will be sent C.O.D.

Our responsibility ceases when parts are delivered in good condition to the transportation companies.

Claims for damages in transit are to be made by the consignee.

ALL PRICES SUBJECT TO CHANGE WITHOUT NOTICE.

WHEN RETURNING PARTS FOR ANY PURPOSE

All packages or boxes should be plainly tagged with sender's name and address for identification when received.

Full particulars of shipment should be mailed to factory at time shipment goes forward.

Prepay all transportation charges.

DO NOT return for exchange or credit, parts which have been worn through use or damaged by accident.

Material on which replacement or credit is expected must be returned, all charges prepaid as soon as possible. Do not delay or you may lose your claim.

TELEGRAPH SHIPPING CODE

When ordering parts by telegraph, the message should invariably commence with shipping instructions.

For economy and brevity, a code word covering all general shipping instructions will be found below.

Following the shipping instructions should come, in order, the quantity of parts required, the part number, the part name and the serial number of the machine.

ALIKE	Add to our order:
ALLAY	Enter our order for:
ALLEGE	Enter our order and ship immediately:
ALLIED	Please refer to your order:
ALOFT	Have you shipped:
ALONE	How soon can you ship:
ALOUD	Give price and best delivery on:
ALUM	How did you ship and when:
AMASS	If ordered at once we could ship:
AMBLE	Ship by Parcel Post:
AMEND	Ship by express:
AMONG	Ship by freight:
AMITY	We have in stock:
AMOUNT	We are shipping today:
AMUSE	We can ship:
ANATOMY	We can ship immediately:
ANCHOR	When did you ship:
ANGLER	We will ship about:
ANGRY	Not in stock, can furnish:
ANNOY	Item should read:
ANNUAL	Necessary to have sample:
ANOINT	Order is not clear, please advise regarding:
ANON	Parts ordered were shipped by express on:
APPALL	Parts ordered were shipped by mail on:
ARID	Parts ordered were shipped by freight on:

FOREWORD

Every machine is thoroughly tested and inspected before leaving the factory.

Like any other piece of machinery it should be lubricated at the proper time with the proper grade of oil and grease in order to keep it in first-class condition. All working parts should be free from dirt and grit. Systematic and periodic inspection should be made for loose nuts and connections. It is always cheaper in the long run to have repairs made by a competent mechanic.

REPAIR PARTS ORDERS

Orders for repair parts and inquiries concerning the operation and maintenance of the machine should be addressed to the *nearest parts depot.*

List of Parts Depots and Offices

BATTLE CREEK

BATTLE CREEK, MICHIGAN

BIRMINGHAM, ALABAMA
407 N. 24th St.

JERSEY CITY 2, NEW JERSEY
34 Exchange Place

TORONTO, ONTARIO
J. H. Ryder Machinery Co.
55 York Street

LOS ANGELES 21, CALIFORNIA
1716 E. 7th St.

PITTSBURGH, PENNSYLVANIA
319 Third Ave.

MONTREAL, P. Q.
T. E. Ryder Machinery Co.
635 St. Paul St., W.

List of Branches and Offices

BOSTON, MASSACHUSETTS
95 Binney St.
Cambridge, Massachusetts

DETROIT, MICHIGAN
2211 Fisher Bldg.

HOUSTON, TEXAS
1302 Petroleum Bldg.

MEMPHIS 3, TENNESSEE
963 Union Ave.

PORTLAND, OREGON
1238 N. W. Glisan St.

SEATTLE 4, WASHINGTON
2207 First Ave., S.

WASHINGTON 5, D. C.
Room 913, 927 Fifteenth St., N. W.

CHICAGO 4, ILLINOIS
600 S. Michigan Ave.

DENVER 2, COLORADO
420 U. S. National Bank Bldg.

HONOLULU, T. H.
P. O. Box 300

INDIANAPOLIS, INDIANA
5310 Central Ave.

PHILADELPHIA 7, PENNSYLVANIA
1335 Real Estate Tr. Bldg.

SAN FRANCISCO, CALIFORNIA
383 Brannan St.

ST. LOUIS, MISSOURI
3957 Forest Park Ave.

TULSA, OKLAHOMA
525 Gillette St.

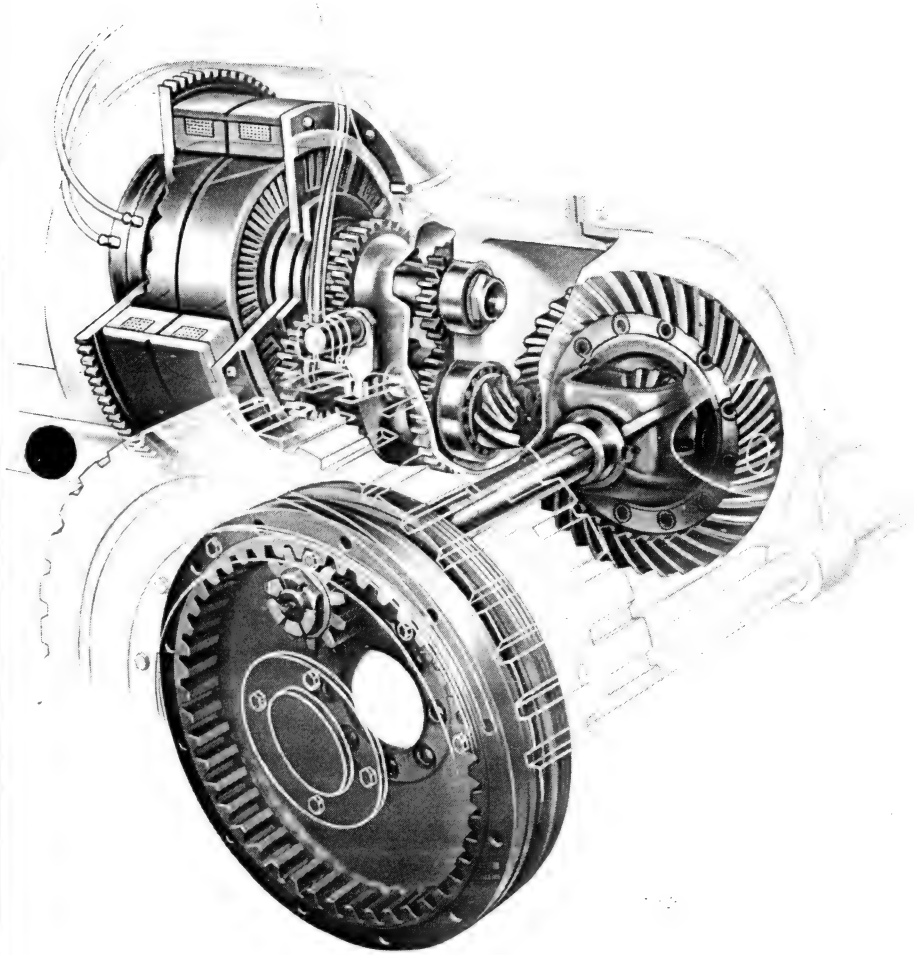
VANCOUVER, B. C.
National Machinery Co., Ltd.
Granville Island

EXPORT OFFICE
NEW YORK, NEW YORK, U. S. A.
O. Philipp & Co. — 19 Rector Street

CLARK EQUIPMENT COMPANY
INDUSTRIAL TRUCK DIVISION
BATTLE CREEK, MICH., U. S. A.

DYNA-TORK Drive

CARLOADER YARDLIFT-40 AND 60 UTILITRUC



WITH THESE FEATURES:

NO CLUTCH

Engine power transmitted to constant mesh transmission by magnetic induction through an air gap. Direction of travel controlled by energizing forward or reverse magnetic field.

MORE WORK

Powerful, heavy duty field insures instant power response. Increased maneuverability due to simplified driving controls. Fast, dependable inching control for operation in confined areas.

FINGERTIP CONTROL

Positive driver control. One finger moves the selector switch on the steering column which controls forward, reverse, and neutral.

DEADMAN SAFETY

Selector switch automatically returns to and locks in neutral when driver leaves seat and cannot be moved until the driver is again seated.

REDUCED DRIVER FATIGUE

Eliminates constant clutching and declutching operations and shifting of gears necessary in conventional friction drives. Simple movements control complete operation of truck.

MINIMUM MAINTENANCE

Wear and tear on most vital parts reduced. Magnetic induction eliminates frictional contact between driving and driven members. No clutch to change. Constant mesh transmission eliminates gear clashing.

INDUSTRIAL TRUCK DIVISION

CLARK EQUIPMENT COMPANY

BATTLE CREEK, MICHIGAN

SPECIFICATIONS

CARLOADER **ENGINE SPECIFICATIONS**

MODEL: Continental F-4140

NUMBER OF CYLINDERS: 4

BORE AND STROKE: 3 3/16 x 4 3/8

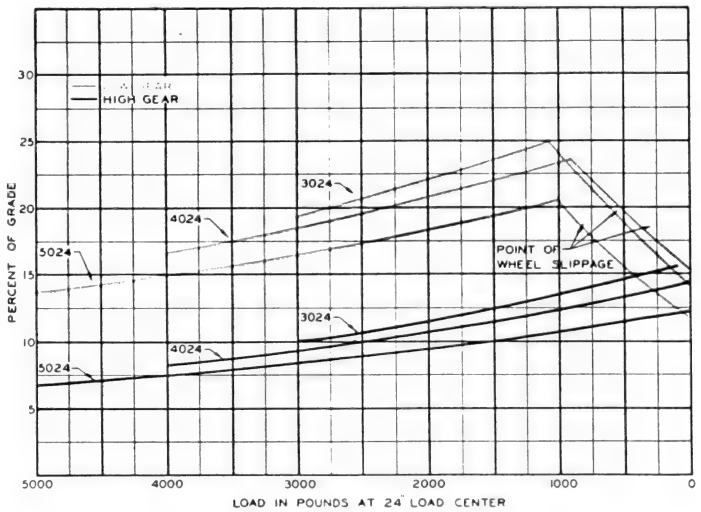
CUBIC INCH DISPLACEMENT: 140

BRAKE HORSEPOWER: 34 at 1800 r.p.m.

TORQUE: 108 at 1400 r.p.m.

SPEEDS: up to 7 miles per hour.

WEIGHTS: Increased 100# over standard clutch model.



YARDLIFT-4024 **ENGINE SPECIFICATIONS**

MODEL: Continental F-4140

NUMBER OF CYLINDERS: 4

BORE AND STROKE: 3 3/16 x 4 3/8

CUBIC INCH DISPLACEMENT: 140

BRAKE HORSEPOWER: 38 at 1950 r.p.m.

TORQUE: 108 at 1400 r.p.m.

SPEEDS: up to 11.5 miles per hour.

WEIGHTS: Increased 100# over standard clutch model.

YARDLIFT-6024 **ENGINE SPECIFICATIONS**

MODEL: Continental F-6209

NUMBER OF CYLINDERS: 6

BORE AND STROKE: 3 3/16 x 4 3/8

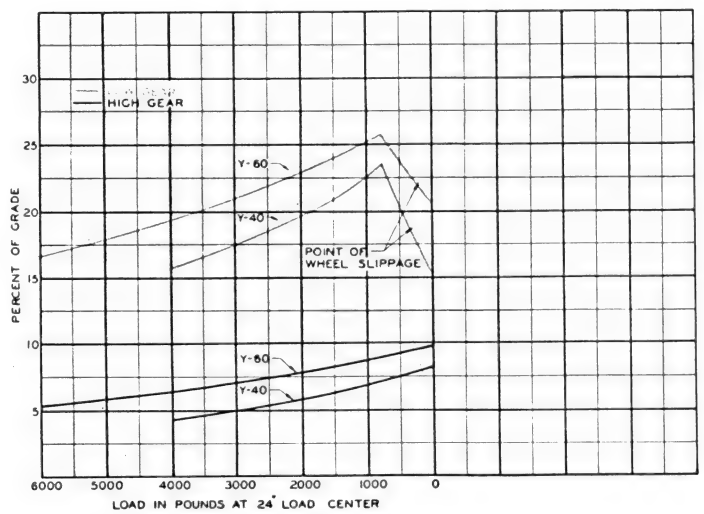
CUBIC INCH DISPLACEMENT: 209

BRAKE HORSEPOWER: 50 at 1800 r.p.m.

TORQUE: 153 at 1200 r.p.m.

SPEEDS: Up to 11.5 miles per hour.

WEIGHTS: Increased 200# over standard clutch model.



1000 LBS. ELEC-TRUCLOADER

2000 LBS. GAS CLIPPER

3-4-5000 LBS. ELEC-CARLOADER

10,000 LBS. GAS UTILITRUC-100

15,000 LBS. GAS YARDLIFT-150

SPECIFICATIONS

UTILITRUC AND UTILITRUC-100
ENGINE SPECIFICATIONS

MODEL: **Continental F-6209**

NUMBER OF CYLINDERS: **6**

BORE AND STROKE: **3 3/16 x 4 3/8**

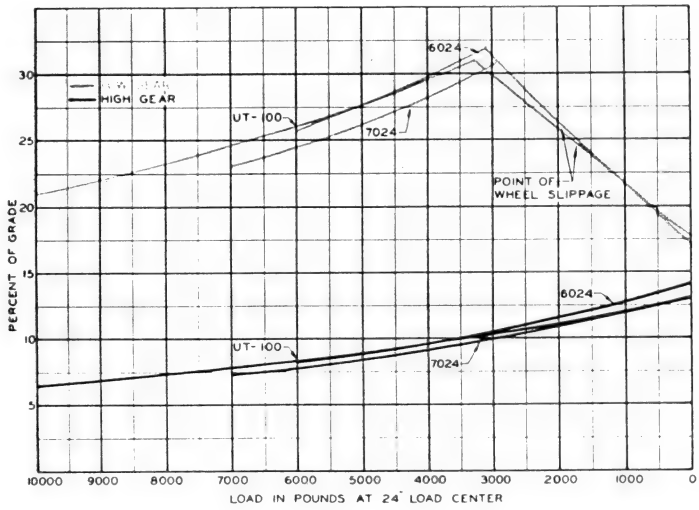
CUBIC INCH DISPLACEMENT: **209**

BRAKE HORSEPOWER: **50 at 1800 r.p.m.**

TORQUE: **153 at 1200 r.p.m.**

SPEEDS: **Up to 7.1 miles per hour.**

WEIGHTS: **Increased 200# over standard clutch model.**



HOW DYNATORK DRIVE WORKS!

HEAVY DUTY FIELD

The driving force consists of two magnetic coils bolted on the flywheel. The coils rotate with the flywheel and are each surrounded with eight poles which transmit the driving current — one coil for forward, the other for reverse.

CAST ROTORS

The driven members are two rugged cast rotors mounted within the magnetic coils. There is an air gap between the rotors and their respective coils. Both the forward and reverse rotors are attached to the special constant mesh transmission.

DIRECTIONAL SELECTOR SWITCH

Fingertip control of forward, reverse and neutral is provided by a selector switch mounted on the steering column — move the switch lever forward to go ahead; move it backward for reverse; leave it at neutral when movement is not required.

When the forward magnetic coil, for example, is energized by moving the selector lever forward, a high-density magnetic field is set up between the coil and the forward rotor. This induced driving force in turn is transmitted through the transmission to the axle and wheels.

CONSTANT MESH TRANSMISSION

No metal-to-metal contact between the driving magnetic coil on the flywheel and the driven rotor on the transmission shaft since the inductive force is applied through an air gap. This eliminates the necessity of changing gears when reversing direction, since the entire transmission is in constant mesh and reverses in response to the change in the rotor that is being energized. Both rotors and field coils always rotate in the same direction regardless of direction of travel on the truck.

AUTOMOTIVE CONTROLS

The familiar accelerator controls operating speed. In order to accomplish "inching" operations when slow and careful maneuvering is required, necessary variations of voltage to flywheel coils is achieved through use of a foot pedal to the left of the steering column.

A "high-low" lever, in the familiar floorboard position, permits manual selection of "high" or "low" speed. Normally the fork truck performs all functions in "high"; "low" is used only for extreme grades or unusual operating conditions.

SAFETY

The directional control lever is mechanically connected to the seat so that when the driver leaves the seat, the lever is automatically returned to and locked in neutral. The lever cannot be moved until the driver is again seated. Thus a positive "deadman" control is assured.

POWER SUPPLY

Electrical energy requirements are supplied by a constant-output dual belt heavy duty 6 volt, 50 ampere generator which also supplies current for standard ignition system.

The only wearing parts are the brushes that run on the collector rings.

SPECS MAY BE CHANGED IN PROCESS OF PRODUCTION WHEN DEEMED ADVISABLE
DYNATORK DRIVE DOES NOT ALTER DIMENSIONAL SPECIFICATIONS OF STANDARD MODELS

200 LBS. DBP

POWRWORKER TUGGER

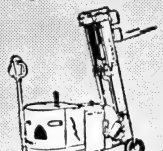
2-2600 LBS. DBP

GAS CLARKAT

2-12,000 LBS. DBP

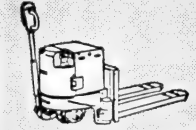
GAS CLARKTOR

15-3000 LBS.



POWRWORKER STACKER

6000 LBS.

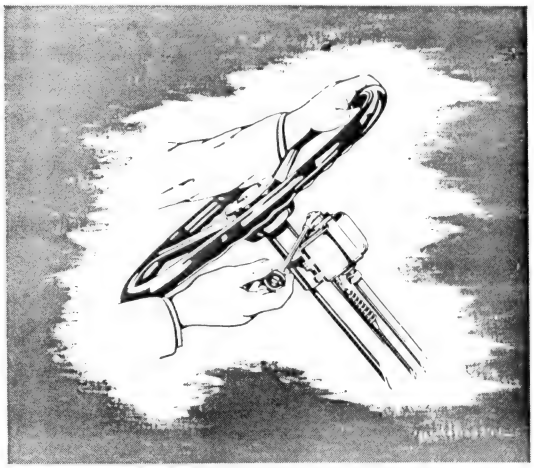


POWRWORKER PALLET

gas powered DYNATORK DRIVE fork-lift truck

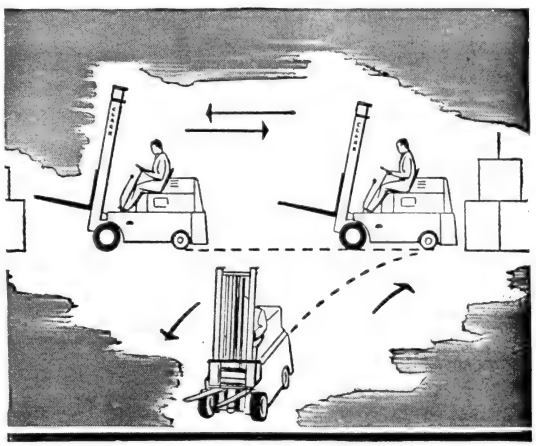
DIRECTIONAL LEVER — NO CLUTCH —

No gears to shift — either mechanically, hydraulically or manually — either for truck acceleration or for changing direction of travel. The directional-control lever mounted on the steering column routes electrical current to either the forward or reverse coils which surround the rotors. In this manner the direction of movement can be changed without the necessity of changing the position of the transmission gears. A "high-low" control lever permits selection of a low-gear ratio if unusual conditions warrant. For normal operations lever remains in "high" position during all truck movements.



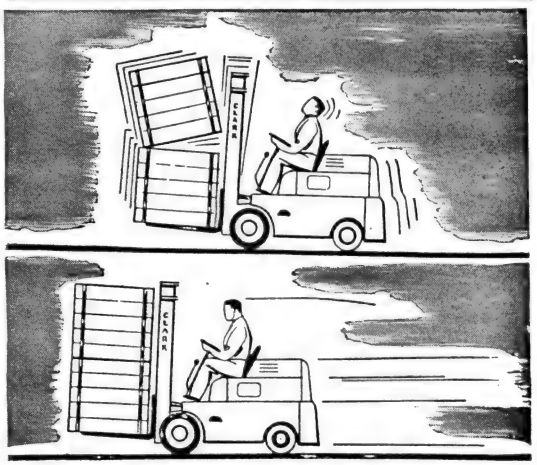
IN CONFINED AREAS — NO CLUTCH —

When conventional-drive fork-lift trucks are operated in confined areas where short forward and reverse movements are necessary, the many clutching and de-clutching operations are certain to result in above-average maintenance problems. This clutching for change of direction is necessary even with fluid-drive power units. With the Dynatork Drive, reversing the direction of movement — no matter how frequently — causes *no* wear, *no* tear on the drive unit.



SMOOTH, SAFE STARTS — NO CLUTCH —

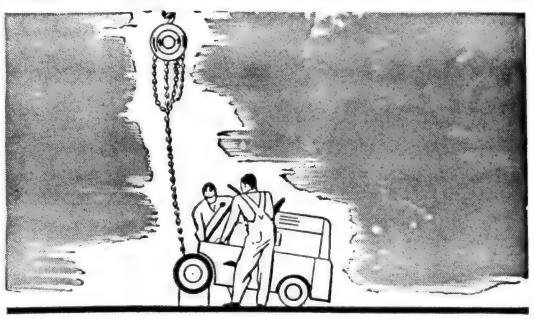
Smooth, even flow of power provided by the Dynatork Drive virtually eliminates the possibility of toppling and damaging fragile loads as a result of jerky starting and accelerating. Even though the directional-control lever is reversed when the truck is in motion, the slow-down and change of direction occur without jerk or jar.



REDUCED MAINTENANCE — NO CLUTCH —

Any machine out of service is a liability rather than an asset. Since wear and tear are unavoidable, the next best thing is to reduce them to a point where "down-time" for repairs and service becomes negligible.

This is precisely what Dynatork Drive does. In eliminating metal-to-metal contact between driving and driven members, it removes the wear-and-tear factor on a most vital part of the fork truck, thus keeping the machine *in* rather than *out* of service and minimizing repair costs.



INDUSTRIAL TRUCK DIVISION **CLARK EQUIPMENT COMPANY** **BATTLE CREEK, MICHIGAN**

Printed in U.S.A.

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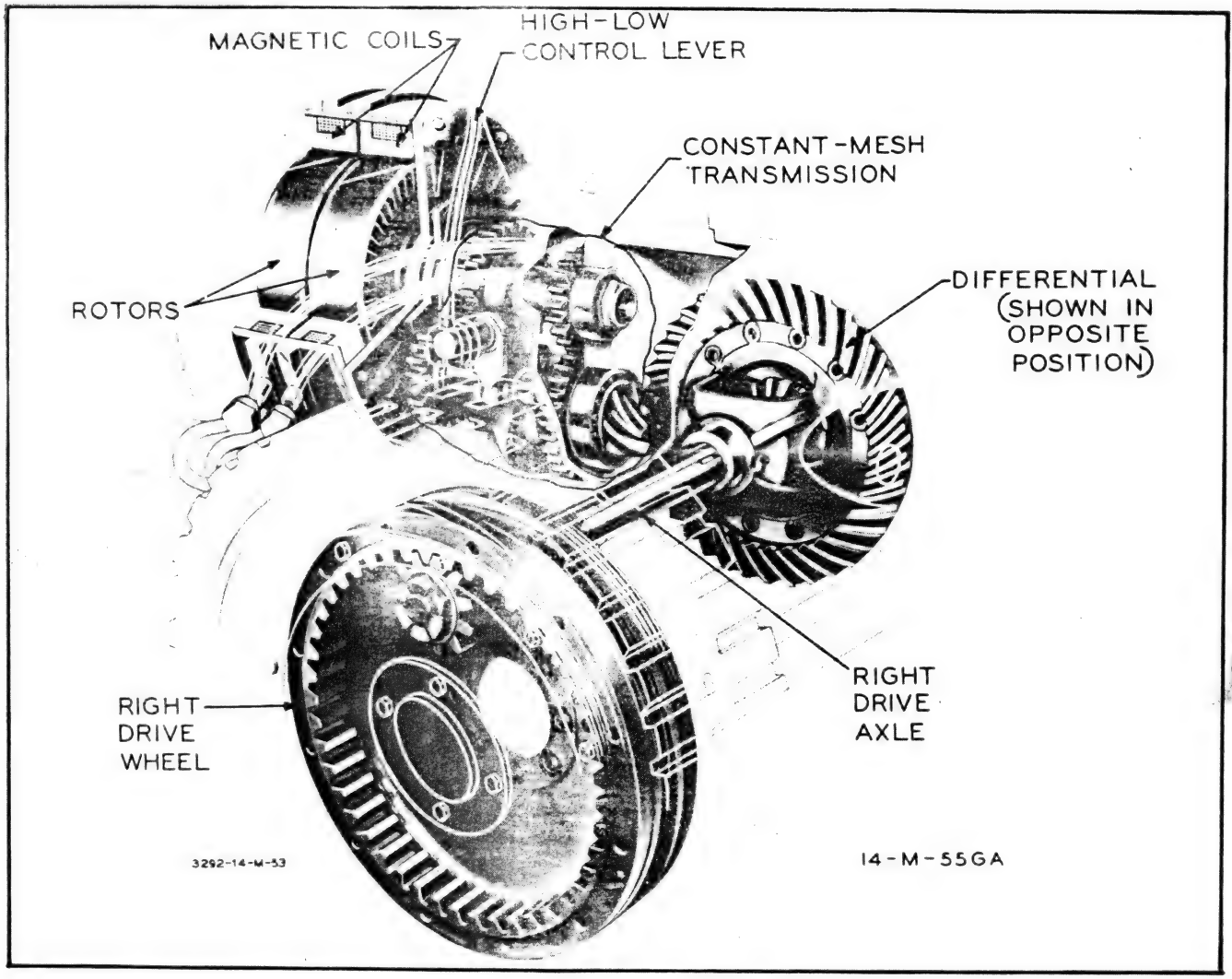


Clark Dynatork Drive

DYNATORK DRIVE

The Dynatork Drive mechanism is an electromagnetic device used in place of the conventional clutch to transmit the rotation of the flywheel to the transmission.

The mechanism of the system consists of the following units; circuit breaker, caterpillar resistor, directional switch, two positive brushes and a special flywheel.

CIRCUIT BREAKER

The circuit breaker is electrically located between the power source and the caterpillar resistor. It is physically located on the left rear side of the sump tank.

The circuit breaker acts as a safety switch and will automatically break the circuit to the Dynatork unit in case of excessive amperage draw in the circuit.

If circuit breaker opens, determine and correct trouble before pushing reset lever to "on" position.

MAINTENANCE

In case of a defective circuit breaker, replace as a unit. Do not try to service.

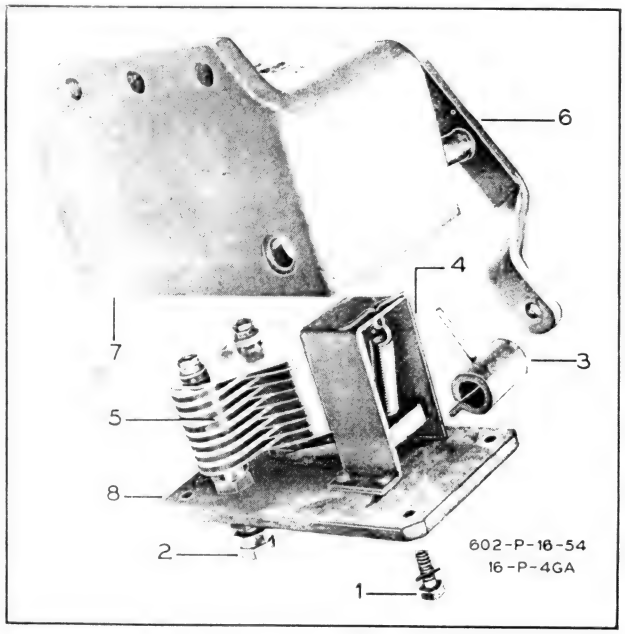


Fig. 1. Caterpillar Resistor

CATERPILLAR RESISTOR (Refer to Fig. 1.)

The caterpillar resistor is used to manually control the input to the Dynatork unit.

When the control pedal is fully depressed, the circuit is completely opened, thus allowing no power to flow to the Dynatork unit. The flow of power increases gradually as the pedal is released. Maximum flow of power to the Dynatork unit is obtained with pedal fully released. The caterpillar resistor is located under the floor plates.

INSPECTION AND MAINTENANCE

Inspect the contact fingers for burning or pitting of the contacts, warped or deformed fingers, or any contact point that is not making contact with the contacts on each side.

Replace any unit that is found to be defective.

Periodically clean the control pedal linkage to keep linkage from binding. Check control pedal return spring for stretching and/or distortion. Keep the pedal linkage and return spring in good working condition. If pedal does not release fully, when foot is removed, the points in the resistor will burn.

When a resistor assembly is found to be defective and is disassembled for repair, replace defective parts with a Resistor and Leaf Kit or as a unit.

DIRECTIONAL SWITCH

The directional switch is located on the steering column.

The lever on this switch controls the forward and reverse movement of the truck. The directional switch is equipped with a safety device that locks the switch in neutral position when the operator is not in the seat.

INSPECTION AND MAINTENANCE

Periodically remove the cover of the switch and inspect the contact points. Points are silver and are not harmed by discoloration and slight pitting. *DO NOT FILE THEM* as dressing merely wastes contact material. Replacement is necessary only when silver has worn thin.

DYNATORK BRUSHES

The Dynatork system makes use of five contact brushes. Two of these brushes, (Fig. 2.) one on each side of flywheel housing, contact the forward collector ring while the other two

contact the reverse collector ring.

The fifth brush is a ground brush and makes contact with forward side of the outboard carrier.

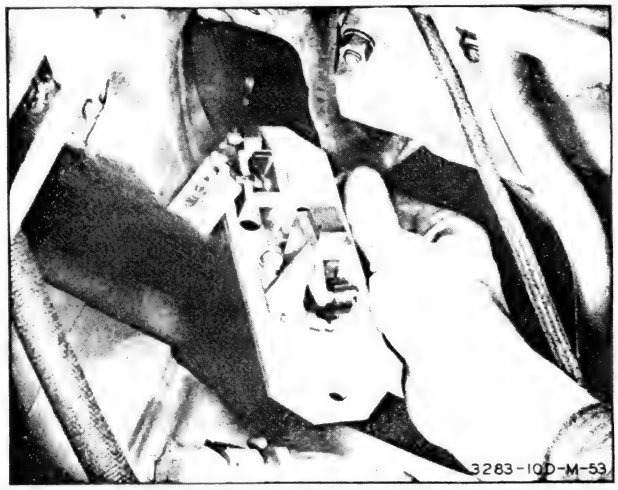


Fig. 2. Checking Brushes

A jumper wire connects the forward brushes together while a second jumper wire connects the reverse brushes.

Constant pressure is kept on the brushes by tension springs.

MAINTENANCE AND INSPECTION

A new brush is 1 1/4" in length and can be used efficiently until it is worn to 3/4" in length. Brushes should be replaced when worn to 3/4".

Having the proper amount of spring tension on the brushes is very important to insure efficient operation of the Dynatork unit. Weak springs will allow the brushes to jump and cause arcing. Excessive spring tension will result in rapid brush wear. Spring tension can be checked with a spring scale. Correct brush spring tension must be 3.5 to 3.75 lbs. If tension of brush springs is less than 3.5 to 3.75 lbs, brush spring should be replaced.

RESISTOR

A 4 ohm center tap resistor is mounted to a plate on the back of the sump tank. Electrically this resistor is located in the field circuit between the forward and reverse fields.

The purpose of the resistor is to reduce the arcing between the brushes and collector rings.

The center tap of the resistor acts as a ground. The terminals at the ends of the resistor are connected, one to the forward field and the other to the reverse field.

MAINTENANCE

Periodically inspect the terminals of the resistor to make certain they are secure.

FLYWHEEL AND HOUSING

NOTE: Ordinarily, the flywheel and housing are considered as parts of the engine. On this model the flywheel and housing are actually a part of the Dynatork System. Therefore, the maintenance of these units will be outlined in this Section.

The flywheel (Dynatork magnetic field) consists of a ring gear, two coils and two collector rings.

The flywheel ring gear is of the conventional type and is used to start the engine.

The two flywheel coils, one forward and one reverse, are used to determine the direction of rotation of the truck and are made as an integral part of the flywheel.

Rotation of the flywheel is obtained when current passes through the brushes to the flywheel collector rings. Direction of rotation is determined by the position of the directional switch on the steering column. With lever in forward position, current flows from two forward brushes to the forward collector ring. The current then flows to the forward coil in the flywheel which in turn energizes the forward rotor which is attached to the transmission. This motion is then transmitted to the drive axle and the truck moves in a forward direction.

By placing the directional switch lever in reverse position, the reverse units of the Dynatork System are energized and the truck moves in reverse.

GENERAL MAINTENANCE

Due to the close tolerances between flywheel and housing the flywheel coils and rotors, it is very important that the space between these units be kept free of dirt, chips and/or any foreign material.

Periodically check all electrical connections to make certain connections are tight and not corroded.

At each 40 hours of operation, direct a stream of compressed air through transmission and flywheel housing vent screens to dislodge any

foreign material. Keep vent screens open to insure proper ventilation of the unit.

Every 40 operating hours, remove brush blocks and inspect collector rings for pits, scores and burning.

COLLECTOR RINGS

If collector rings are rough, badly burned and/or pitted so the brushes cannot make good contact, rings can be turned in a lathe. If necessary, the rings can be turned as much as .060 inch and still operate efficiently.

FLYWHEEL COILS

Defects in flywheel forward and reverse coils will necessitate replacing the flywheel.

FLYWHEEL HOUSING

Thoroughly clean the housing and inspect for cracks and breaks.

The housing must be handled with extreme care and protected, whenever possible, from damage.

The flywheel housing on these models is machined to fit only the cylinder block and crankshaft to which it is attached.

DYNATORK ROTORS

The rotors are removed with the transmission.

There is no actual metal-to-metal contact between rotors and flywheel. Magnetic holding force is applied through an air gap. Rotors are fitted to the flywheel with a .021-.022 inch gap.

Extreme care must be exercised when handling rotors to avoid springing or damaging them.

Because of this small clearance between flywheel coils and rotors. *THE FLYWHEEL HOUSING AND ROTORS MUST BE BLOWN OUT WITH COMPRESSED AIR EVERY 40 OPERATING HOURS, OR MORE OFTEN UNDER MORE SEVERE OPERATING CONDITIONS,* to keep foreign material from lodging between flywheel and rotors.

SEAT SAFETY SWITCH (Deadman Switch)
Refer to Fig. 3.

The safety switch is connected to the directional switch on the steering column.

Its purpose is to lock the directional switch in neutral when the operator is not in the seat.

Maintenance consists mainly of periodic inspections of the mechanism to make certain it is operating correctly.

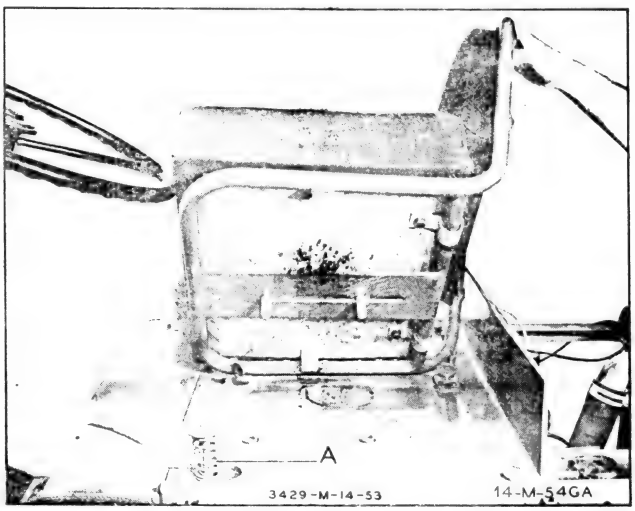


Fig. 3. Seat Safety Switch

If switch does not lock or release properly, adjustment can be made by adjusting clevis.

DYNATORK TROUBLE SHOOTING GUIDE

GENERATOR DOES NOT PRODUCE AMPERAGE:

(1) Check Brushes--
Check spring tension. If weak, replace spring.
Replace brushes if worn short.

Check brushes for freeness in brush holders.
If not, free up.

(2) Check all connections at terminals--
Tighten all loose connections.

(3) Check armature for dirty and worn commutator end--
If dirty, clean with fine sand paper.
If worn or grooved, have commutator trued up and undercut.

(4) Voltage Regulator out of calibration (Current Regulator)--

If generator checks to be proper and all connections are tight then check voltage regulator. If proper instruments are not available regulator and generator should be taken to an authorized service station and calibrated, or regulator should be replaced.

MACHINE DOES NOT MOVE IN EITHER DIRECTION:

(1) No power to field coils--
Check flow of power through Dynatork Drive to determine causes of lack of power.

(2) Forward and reverse cables shorted together at brush holder--
If so, separate leads at this point.

MACHINE DOES NOT MOVE IN FORWARD DIRECTION:

(1) Check voltage to forward brush terminal--
Connect volt meter to top terminal of brush holder mounting plate to ground. This being the forward brush, put directional switch in forward position. Volt meter should register approximately battery voltage, not to exceed one-half volt drop.

(2) Check forward brushes--
Check brushes for freeness in brush holders. If not, free up. If worn short, replace.

(3) Check collector rings--
If dirty, clean with carbon tetrachloride.
If rough, smooth rings with fine sand paper.

(4) If there is power to forward brushes and brushes are free in brush holder and of proper length, and also are seating properly this would indicate that there is an opening in flywheel forward fields. In this case, flywheel assembly will have to be removed.

MACHINE DOES NOT MOVE IN REVERSE DIRECTION:

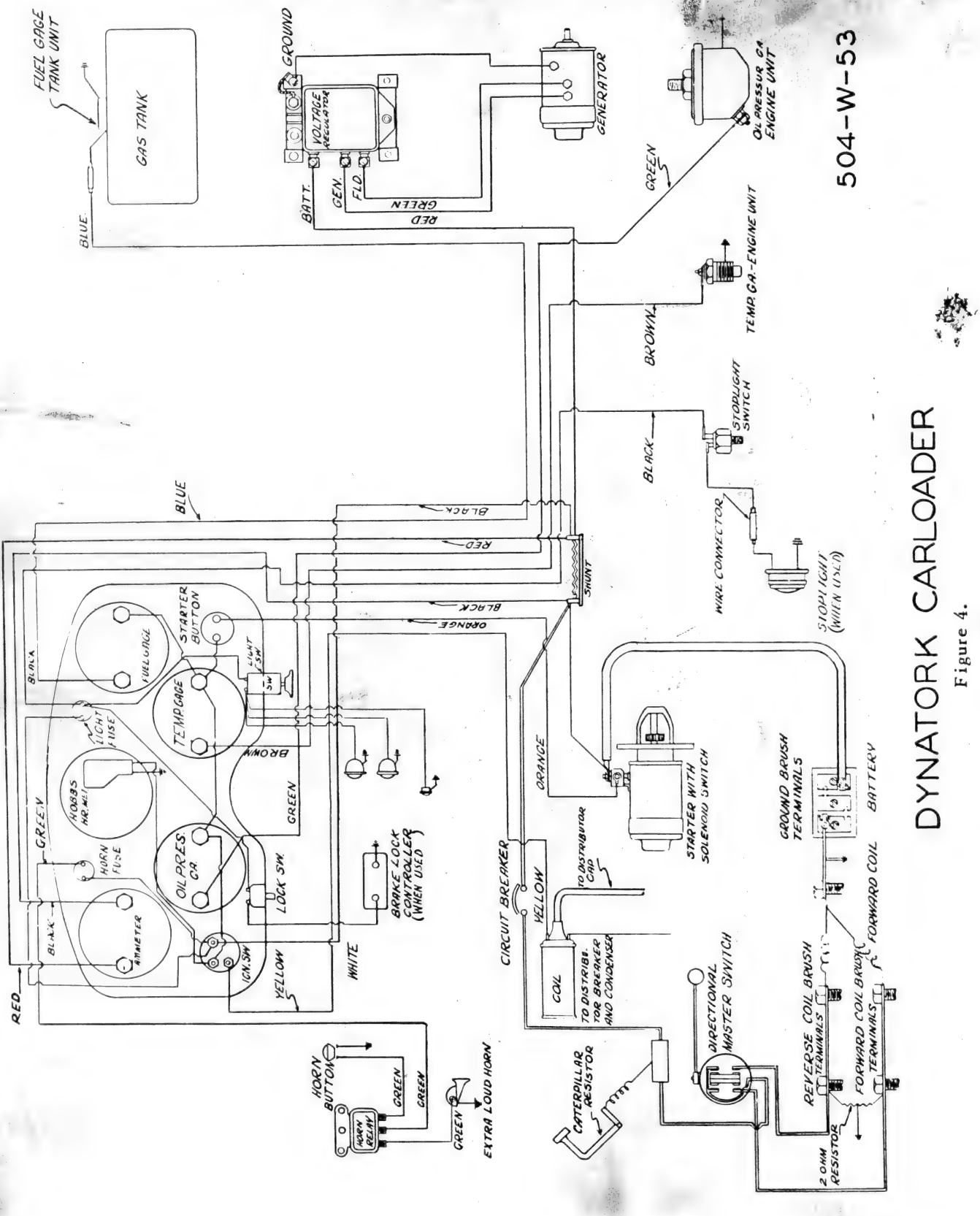
(1) Check in same manner as for condition in forward movement failure, using reverse circuit.

MACHINE LOSES TORQUE AND MOVES SLOWLY:

(1) Check brushes--
Check and determine if brushes are seating properly. If not, replace.
Check brush spring tension. If not sufficient, replace the brush springs.
Check brushes to see if they are free in brush holders.
Free up, if not.

(2) Check collector rings--
If collector rings are dirty they should be cleaned with carbon tetrachloride.
If collector rings are rough or pitted they should be clean and smoothed up with fine paper.

(3) Check caterpillar--
Check flow of current to an through caterpillar resistor. When all fingers are not making contact there will be a resistance in circuit.



DYNATORK CARLOADER

Figure 4.

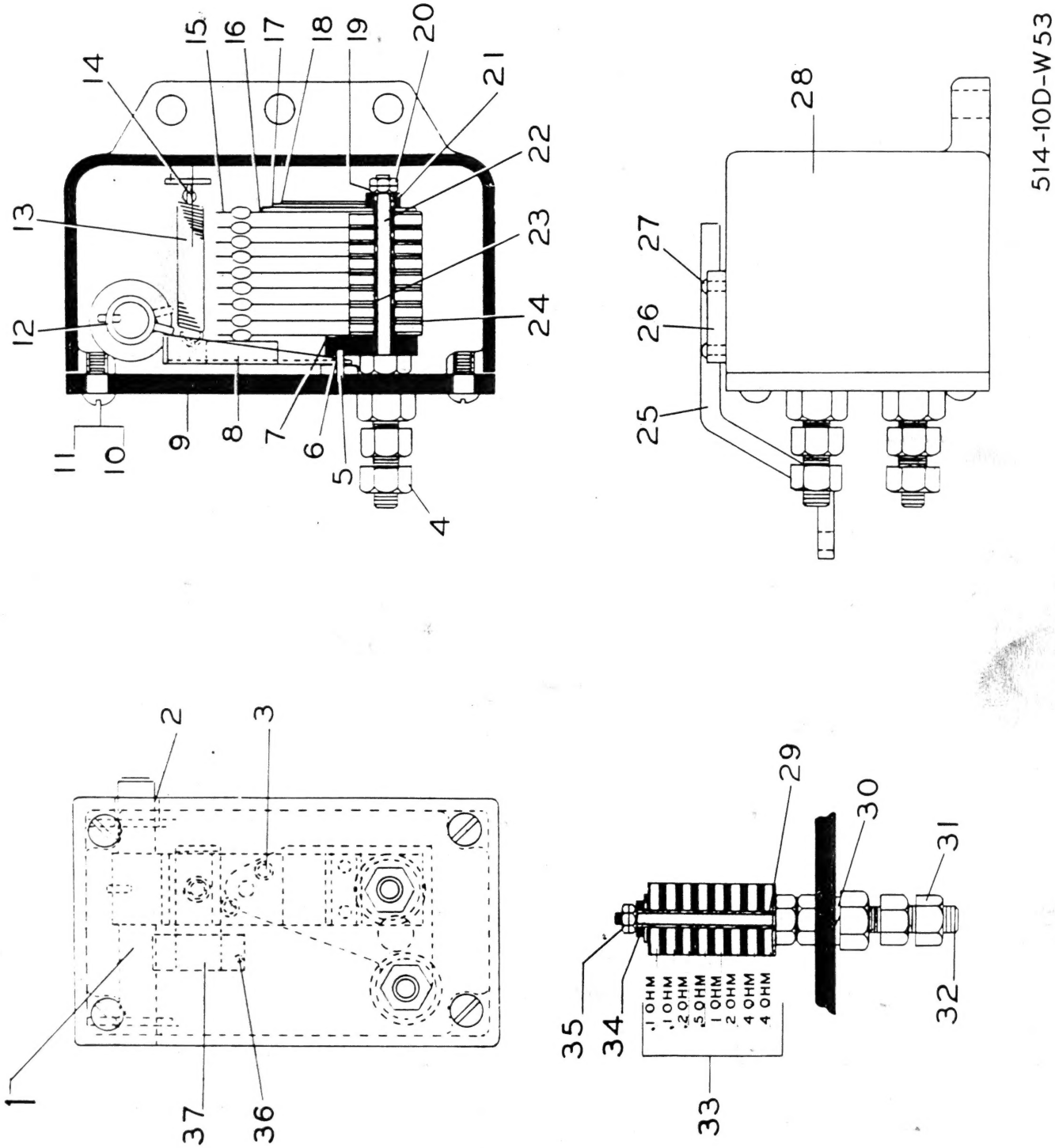
RECOMMENDED LUBRICANT SPECIFICATION
FOR, DYNATORK PILOT BEARING
OUTBOARD SUPPORT PLATE BEARING
AND QUILL SHAFT BEARING

Unworked Penetration	77° - 240
Worked Penetration	77° - 287
Dropping Point	406°F
Base Sodium Soap	15%
Viscosity As Mineral Oil at	100° - 1350
Viscosity As Mineral Oil at	210° - 105
Viscosity Index of Mineral Oil at	95
Copper Strip Corrosion Test @	24 Hr. @ 212° Passed
Oxidation Test Norma Hoffman Bomb	Oxidation Test
	100 hours 3#
	500 hours 10 #

617810 CATERPILLAR ASSEMBLY

Item	Part No.	Description	No. Req'd.
	617810	Caterpillar Assembly (Includes Items 1 thru 46)	1
1	858951	Actuator Cam Shaft	1
2	858955	Oil Lite Bearing	2
3	858963	Rivet	2
4	15D-06	Terminal Nut	4
5	858974	Actuator Base Pin	2
6	858956	Actuator Base	1
7	858958	Leaf Insulator	1
8	858960	Actuator Assembly (Includes Items 3, 14, 38, and 39)	1
9	858938	Control Box Cover	1
10	858967	Control Box Cover Screw	4
11	858975	Control Box Cover Screw Lockwasher	4
12	858953	Actuator Cam	1
13	858939	Actuator Spring	1
14	858962	Actuator Spring Cotter	1

Item	Part No.	Description	No. Req'd.
15	858944	Caterpillar Leaf	9
16	862229	Caterpillar Leaf Spring Plate-Large	1
17	862230	Caterpillar Leaf Spring Plate-Medium	1
18	862231	Caterpillar Leaf Spring Plate-Small	1
19	858971	Terminal Nut Washer	2
20	858907	Terminal Nut	2
21	858941	Contact Spacer	1
22	858943	Terminal	1
23	858940	Terminal Insulator	1
24	858946	Caterpillar Leaf Spacer	16
25	858949	Lever Shaft and Cam Assembly (Includes Items 1, 12, 42 thru 44)	1
26	858957	Lever Arm Stop	1
27	858972	Lever Arm Stop Rivet	3
28	858937	Caterpillar Control Box	1
29	858959	Terminal Insulator	1
30	6E-06	Terminal Lockwasher	2
31	15D-06	Terminal Nut	5
32	858947	Terminal	1
33	858973	Caterpillar Resistor Kit (Includes Items 47 thru 52)	1
34	858942	Contact Spacer	1
35	858907	Terminal Nut	2
36	858969	Spring Support Bracket Rivet	2
37	858965	Spring Support Bracket Assembly (Includes Items 40 and 41)	1
38	858961	Actuator	1
39	858964	Insulator	1
40	858962	Spring Support Bracket Pin	1
41	858966	Spring Support Bracket	1
42	858950	Lever and Shaft Assembly	1
43	858952	Shaft Lever	1
44	858954	Shaft Taper Pin	1
45	862873	Name Plate	1
46	4E-04	Lockwasher	4
47	N.S.S.	.1 ohm Resistor	4
48	N.S.S.	.2 ohm Resistor	2
49	N.S.S.	.5 ohm Resistor	2
50	N.S.S.	1 ohm Resistor	2
51	N.S.S.	2 ohm Resistor	2
52	N.S.S.	4 ohm Resistor	4
53	858946	Caterpillar Leaf Spacer	8
54	862060	Caterpillar Resistor and Leaf Kit (Includes Items 6, 7, 13, 15, 21, 23, 24, 29, 33, and 34)	1
55	863947	Caterpillar Assembly (Unit Less Housing) (Consists of Items 3 thru 9, 13, 15 thru 24, 29 thru 36, and 41)	1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.10HM
.10HM
.20HM
.50HM
1 OHM
2 OHM
4 OHM
4 OHM

Figure 7

CHECKING DYNATORK SYSTEM FOR LOCATING LOSS OF POWER

1. Instruments necessary are volt meter to read tenths and amp meter.

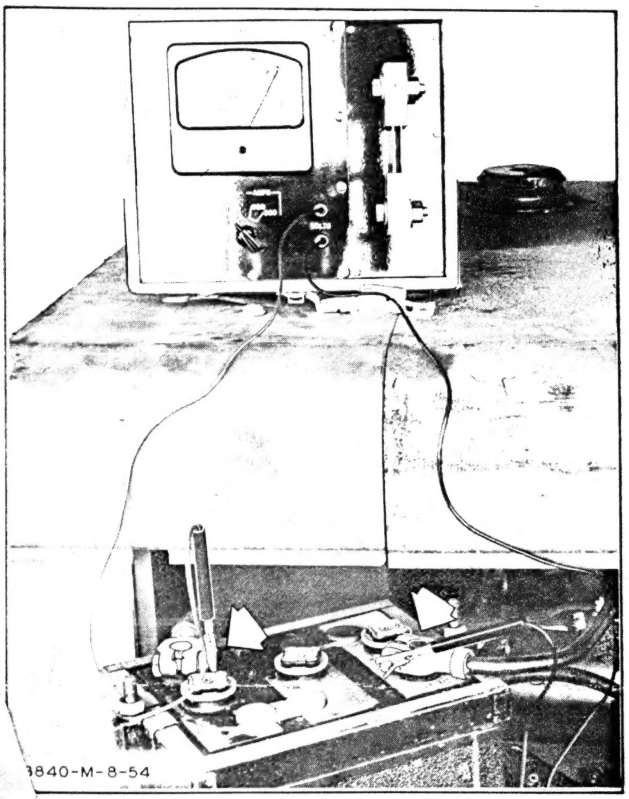

Fig. 8. Checking Battery Voltage

Check battery voltage with directional h in neutral. Min.-6.0 volts, Fig. 8.

Check amperage draw of flywheel by disting brush wires and proceed according wing. Fig. 9. Min. Amp. Draw is 28. If you have less check to see that collector rings are clean and brushes are seated properly. If you have 28 or more amp through the flywheel you can be assured the flywheel is in good condition. Another quicker method is to put the amp meter in series across the directional switch, however, in this method you are checking the complete wiring circuit, instead of just the flywheel fields.

4. Now use the voltmeter to check the circuit for line loss. Be sure and close the directional switch either forward or reverse. Connect - lead f volt meter to post of the battery. Take the + lead of the volt meter to the solenoid of the starter. You will note a voltage drop from battery. Voltage not to exceed - 1.5 volts.

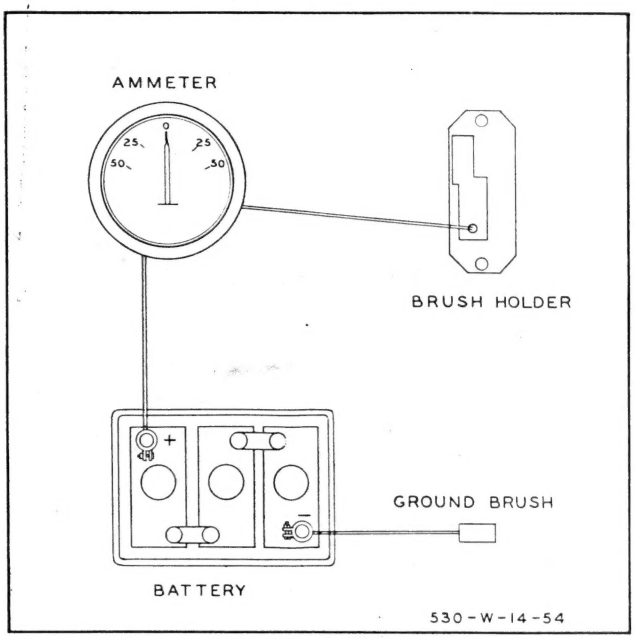

Fig. 9. Checking Amperage Draw Of Flywheel

From this point, take the + lead to the external shunt (Fig. 10), of the amp meter, checking

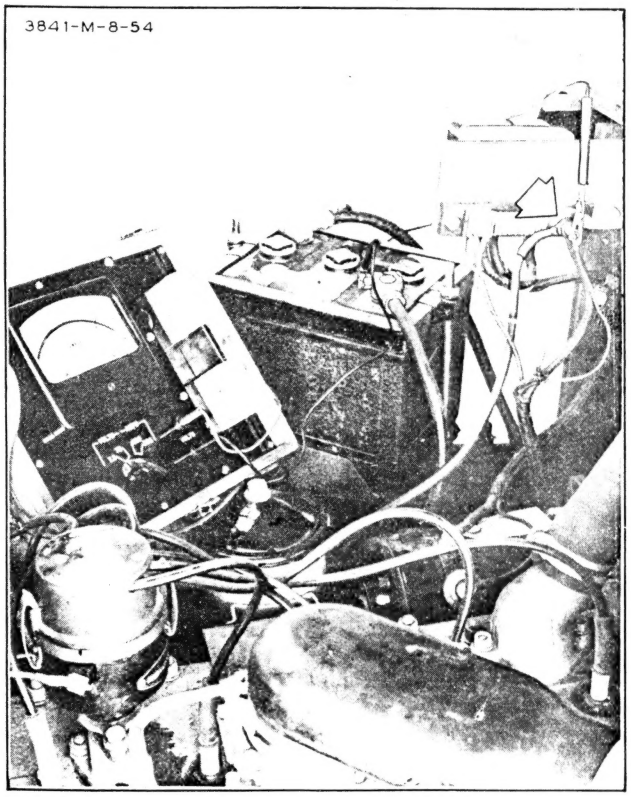

Fig. 10 Checking The Circuit For Line Loss

for line loss. Line loss should not exceed .2 of a volt on any one line. From the shunt take the + lead to the input side of the circuit breaker, then to output side of the circuit breaker. Fig. 11. Checking for loss through the circuit breaker. From the circuit breaker check to the caterpillar resistor and through the resistor Fig. 12 and then to the common side of the directional switch. Fig. 13 (The tips with the shunt between them.)

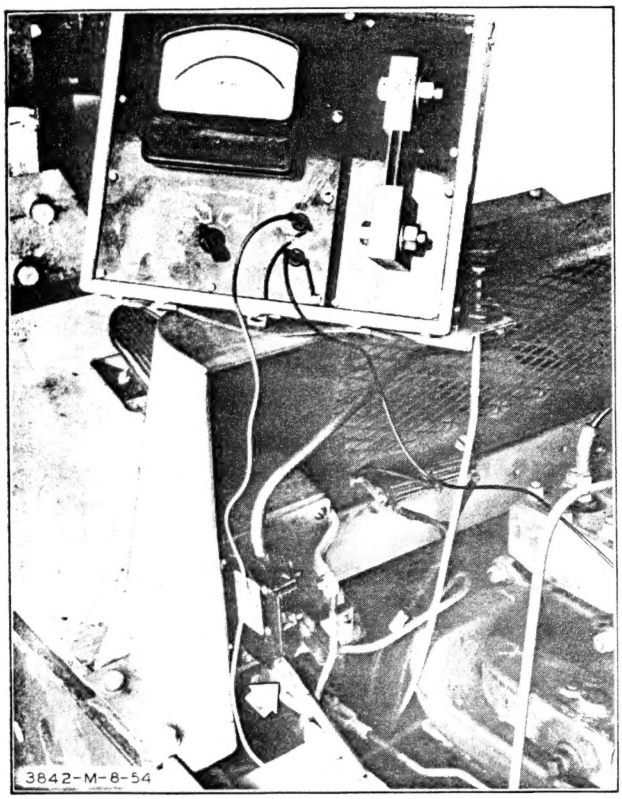

Fig. 11. Checking Circuit Breaker

Now check the forward and reverse side of the directional switch, then on down to the F & R brush holders, and ground brush.

Through one step of this sequence you should be able to locate your trouble.

It is very important that the voltage regulator be set as follows - Voltage 7.7. Cutout 6.8 current regulator 50 amp.

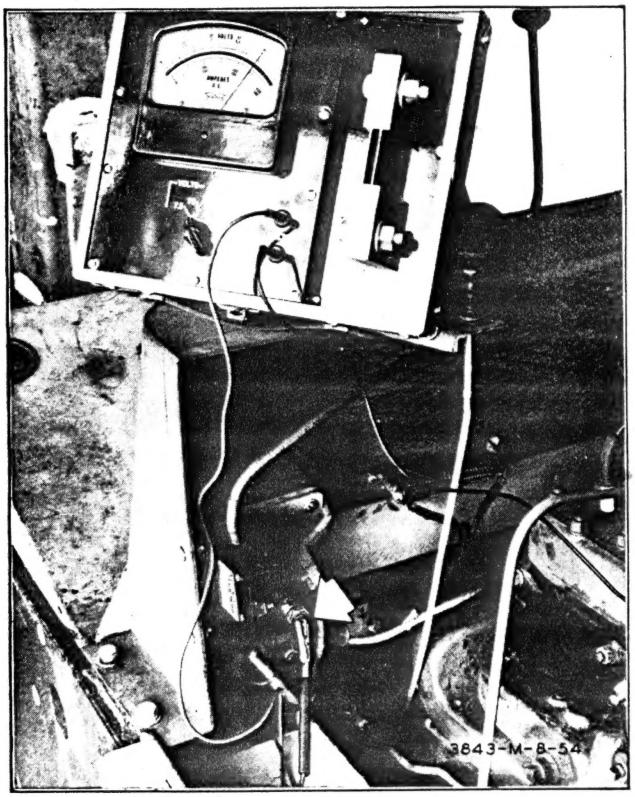

Fig. 12. Checking Caterpillar Resistor

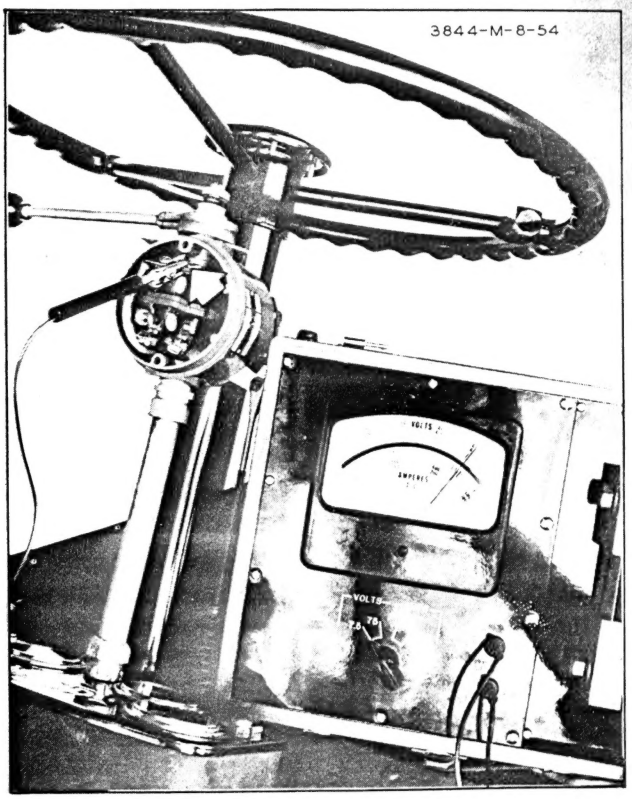

Fig. 13. Checking Directional Switch